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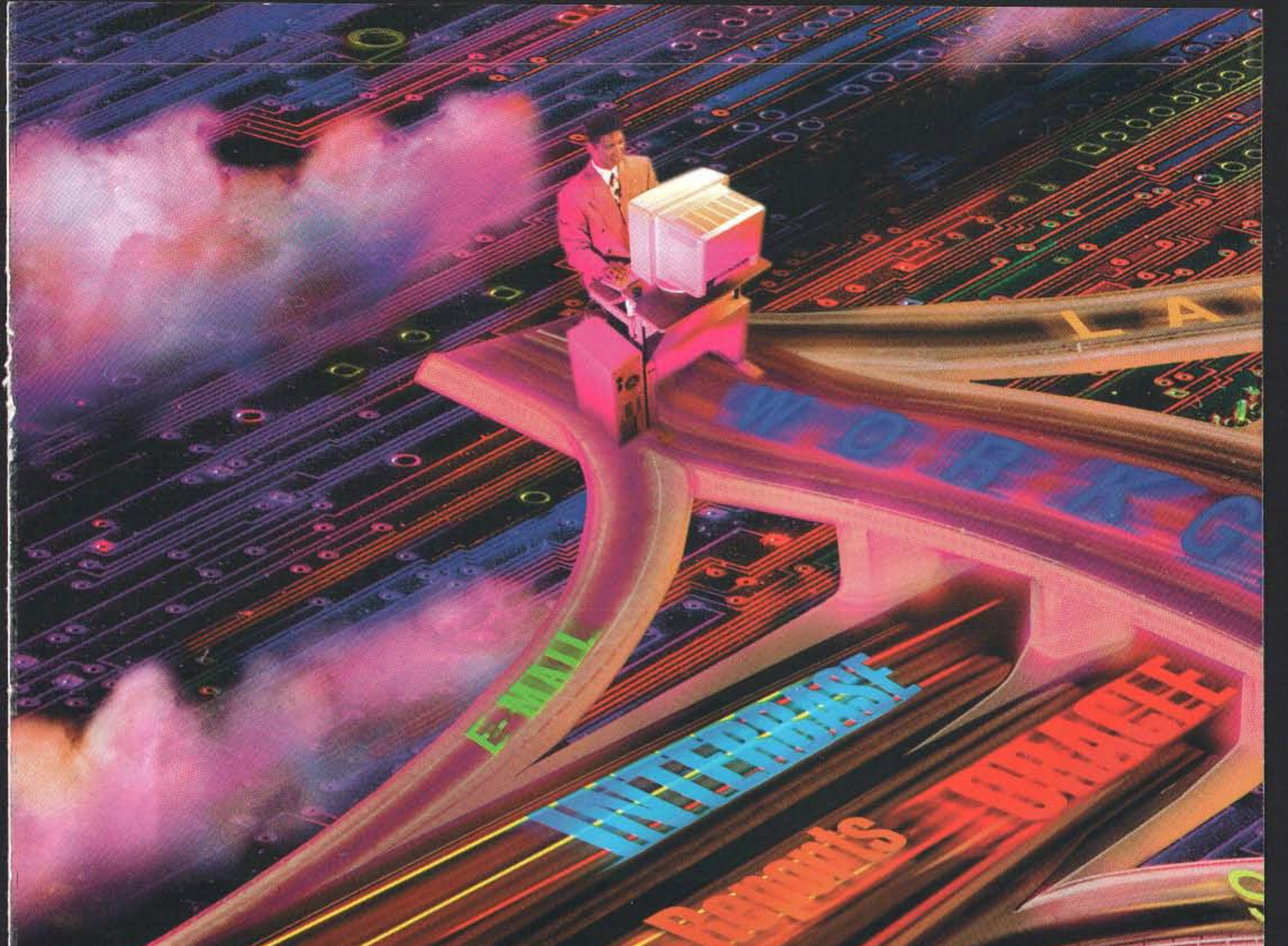

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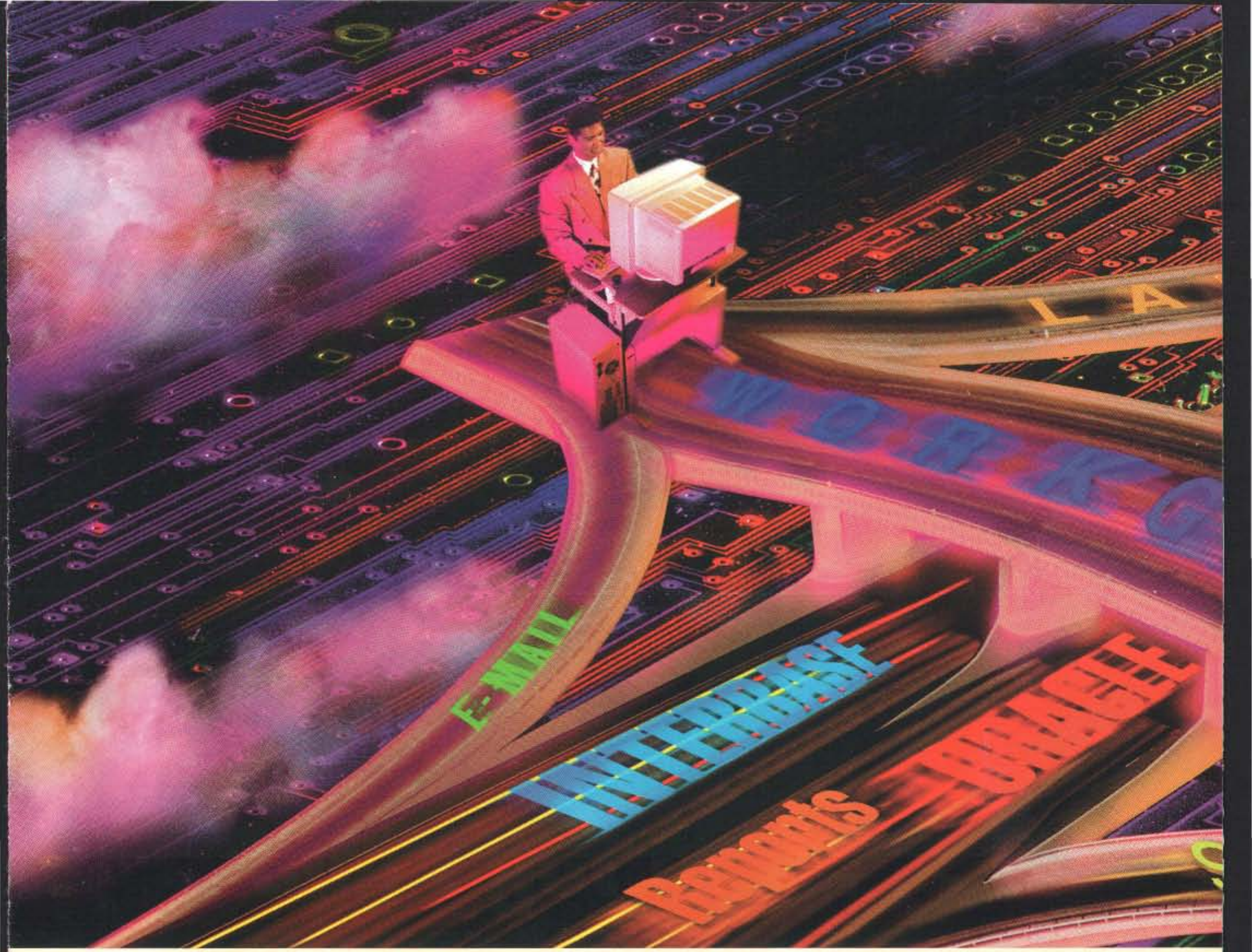
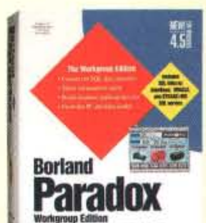
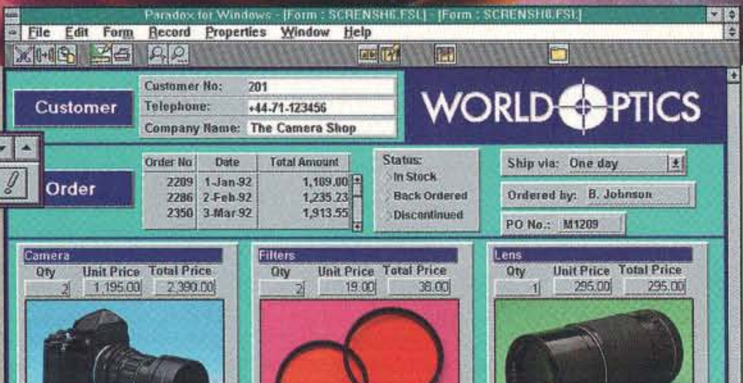




What good is information if you can't get to it . . . or if it can't get to you?

▲ *Keep colleagues up to date quickly, easily. The **Workgroup Desktop** lets you distribute data over a variety of paths—in a mouse-click.*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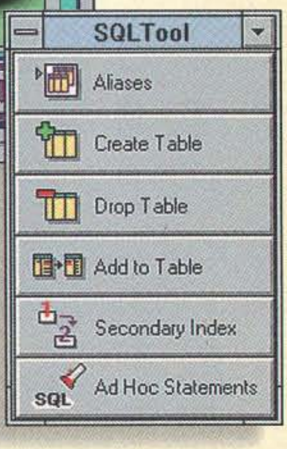

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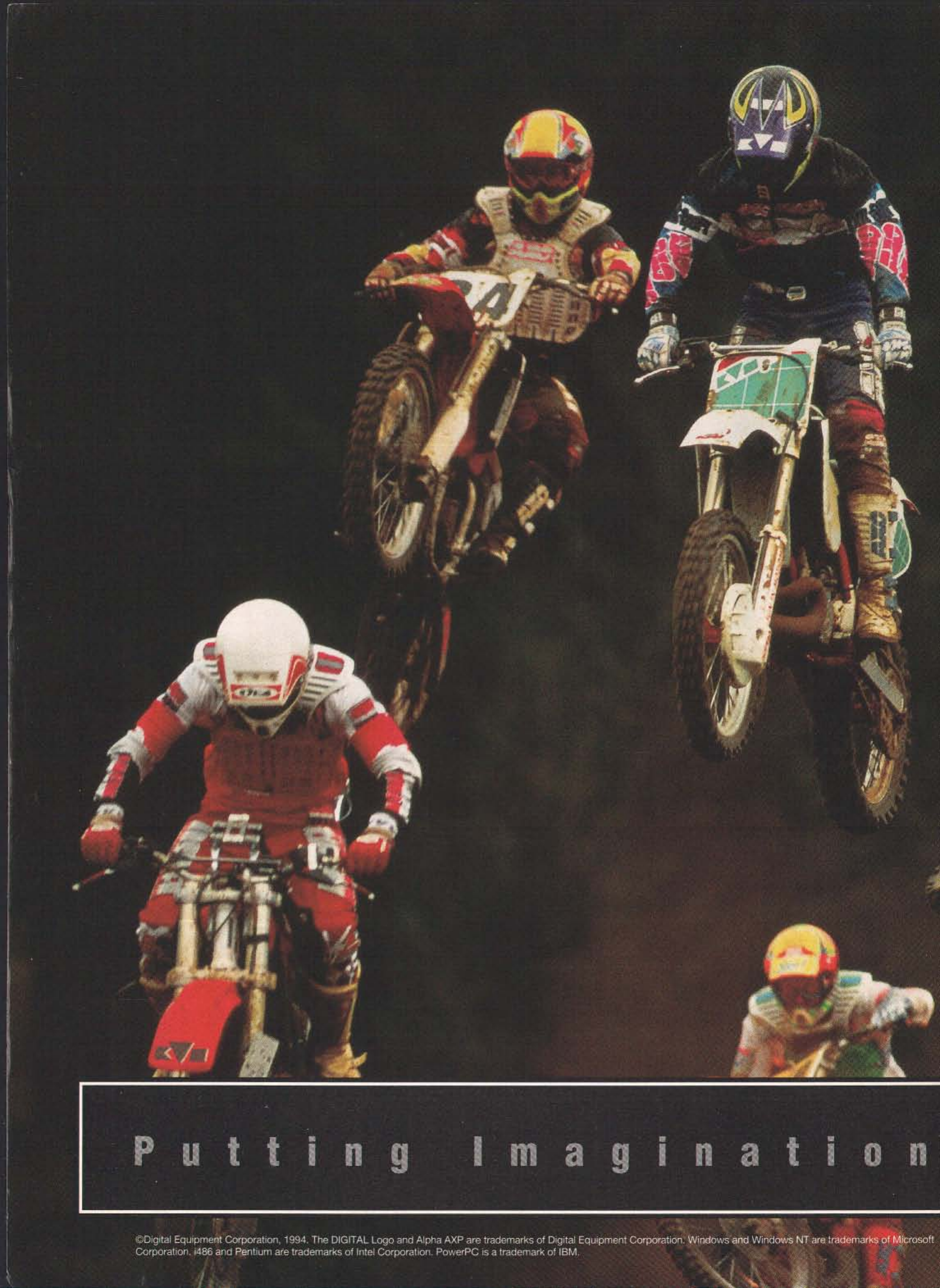

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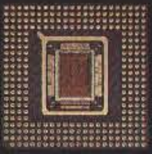

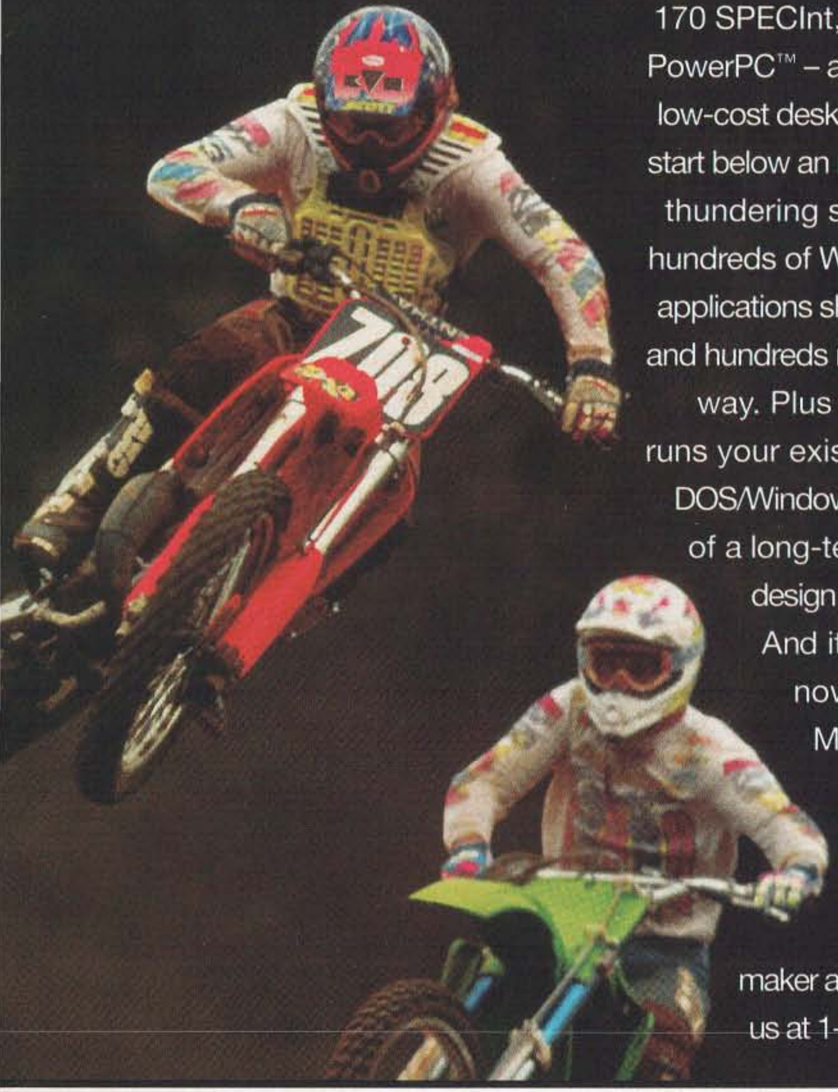

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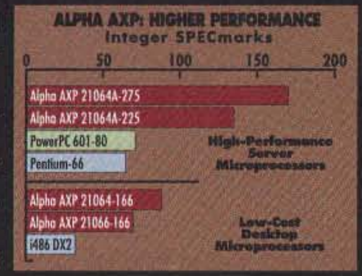

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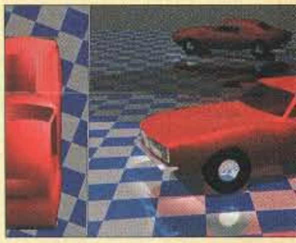

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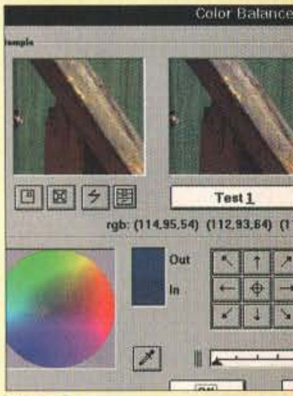

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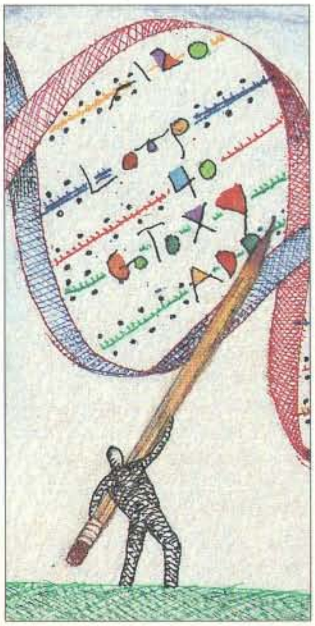

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Hardlock. The art of individual software protection.

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Beyond the GUI

The point-and-click paradigm is stale. We need a more human interface.

In an apparent effort to make computers easier to use, General Magic has developed a new user interface for its Magic Cap operating system. It doesn't look anything like the file folders and program icons you are used to seeing; instead, the new GUI paints an office with a desk that has a telephone, card file, in/out boxes, and so forth. In other words, if you want to check your mail, you simply click on the in-basket on the desk. Need an address? Just click on the Rolodex-like file. You get the idea. You can also go to a file cabinet to take out a file, and a clock on the wall makes office clock watchers feel right at home.

You can even open a door and go down "Main Street" to one of the many office buildings. For example, you might go to the bank building to do electronic banking. It all seems very intuitive—if you've worked with a point-and-click user interface, that is.

This new interface is supposed to make computing more accessible to computer novices, which is a grand and noble idea. And surely every company has some people who would be more productive if computers were less intimidating. Let's face it, Microsoft Windows and the Macintosh interfaces might be a far sight better than a command prompt, but many people don't find either interface to be particularly natural to use.

To these otherwise capable people, ascending the computer learning curve is tantamount to scaling the Matterhorn. The problem is not trivial. Somehow computers must be made easier to use if we expect our enterprise-wide solutions to work. It does no good to restructure an enterprise based on technological solutions (as many large companies are indeed doing), if some people can't use the technology.

For many of us, the problem is sometimes forgotten, because after all, we do not have any problems using computers. For that matter, neither would most of our close associates. But consider the nontechnical workers in your organization; will they be able to navigate through a maze of servers to find that information they need? We may be living in the age of empowerment with information at our fingertips, but so far, the only people who have been empowered are the technically elite.

That has to change. The wave of empowerment that technology creates must be driven down to everyone in an organization if that organization is to truly benefit from the technology. Information must be easily accessible across the enterprise, and systems must be easy to navigate. That's the idea behind General Magic's new GUI.

Bill Atkinson and Andy Hertzfeld, the inventors of the new GUI, are old hands at creating easy-to-navigate interfaces, and they have deservedly earned respect for their early work on the Macintosh user interface. This time, though, Atkinson's and Hertzfeld's work is not so revolutionary. Their new GUI is still based on a point-and-click paradigm. It not only fails to move beyond that basic point-and-click concept, the new GUI perpetuates point-and-click to a new level of complexity.

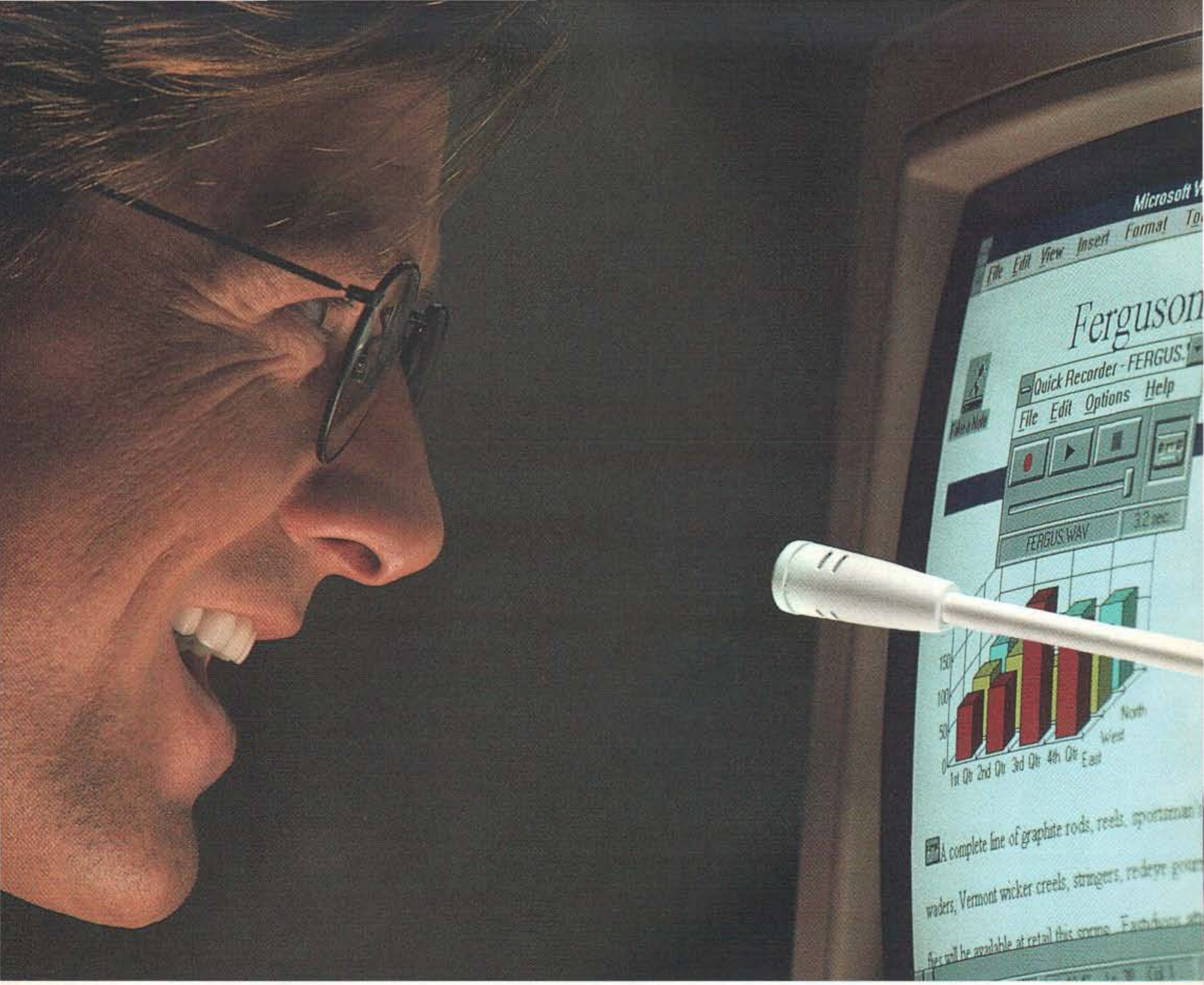
For example, say you want to access the services or database of another company using the Magic Cap interface. With point-and-click mouse or pen gestures, you would have to open the office door, walk down the simulated Main Street, and choose the building that represents the other company. If you're an experienced point-and-clicker, the first time you see someone use the Magic Cap GUI that way it will seem logical. But it doesn't really make sense. Neither does opting for pull-down menus or resorting to programming a macro to perform the tasks, both of which nullify the intent of the new GUI.

So why must you open a door and stroll down Main Street to tell a computer what to do? It seems that the Magic Cap GUI is one that force-teaches users how to converse with a computer, when what we really need are computers that better understand what users want.

It's the computer that must be expected to do the work of understanding if we are ever to empower nontechnical workers. The point-and-click paradigm is stale and overworked, and it's time to move up to the next level: We need user interfaces that listen more like humans and accurately—and automatically—anticipate what users want. Despite all the hype and hoopla, the Magic Cap GUI does not significantly improve user interfaces as did that of the Mac 10 years ago. ■

P.S. With this February issue, I'd like to officially announce the newest member of the BYTE family, BYTE Türkíye, which will publish a version of BYTE in Turkey.

DENNIS ALLEN, EDITOR IN CHIEF
(dallen@bix.com)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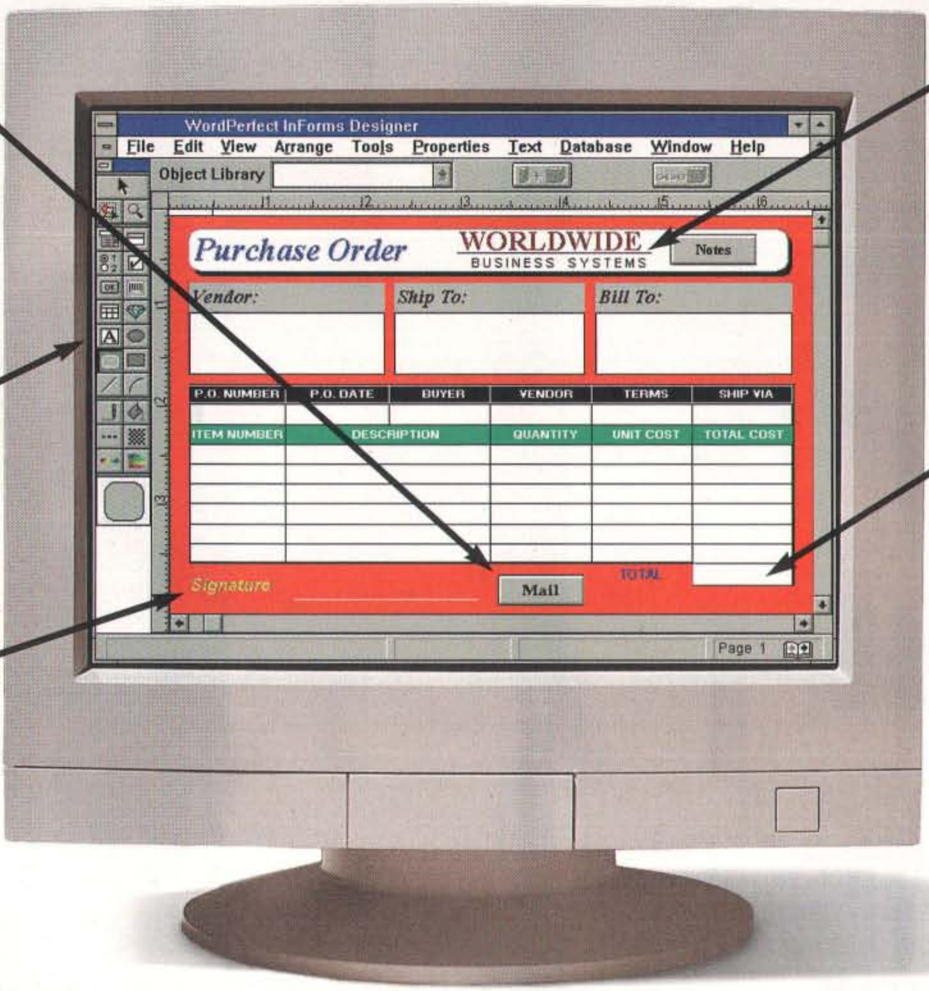

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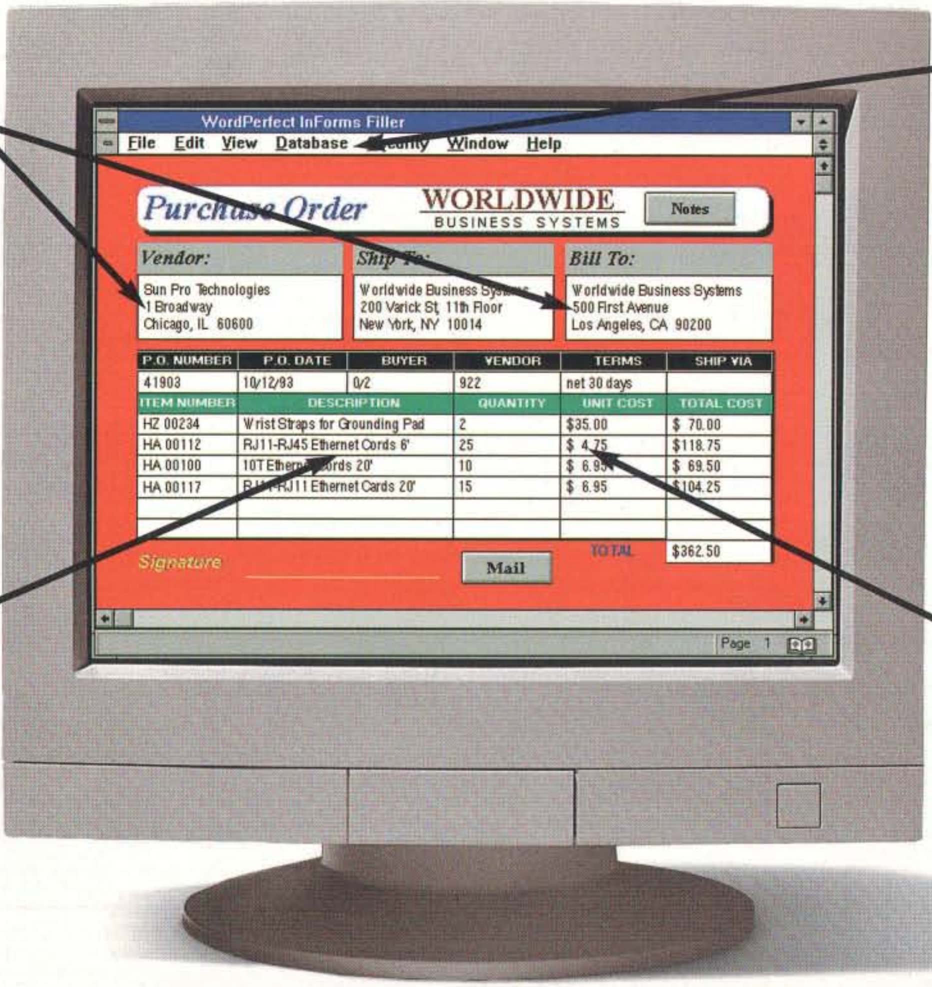

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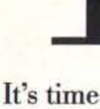

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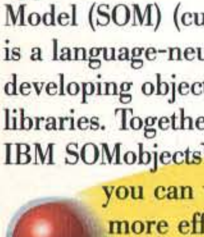

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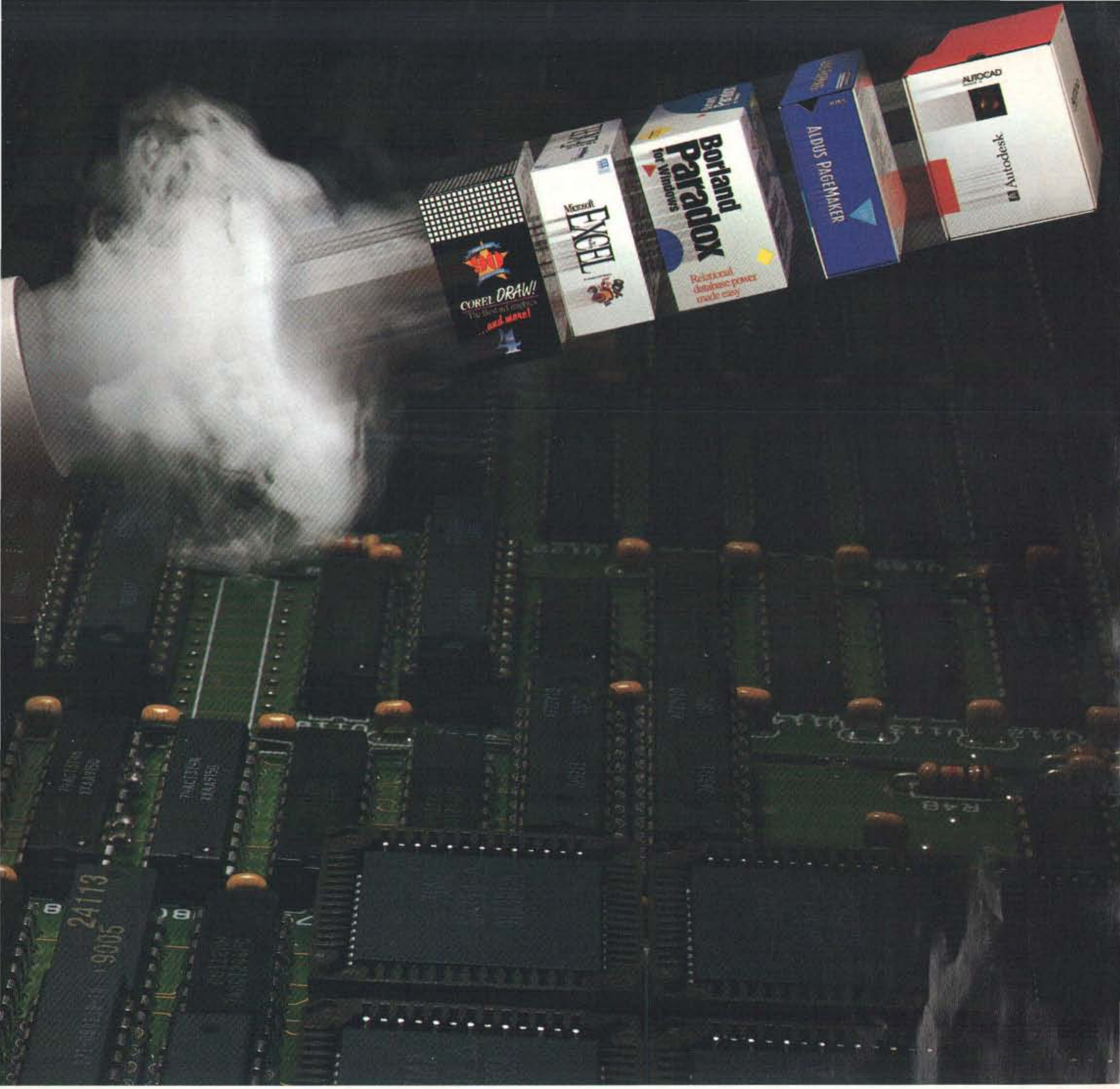

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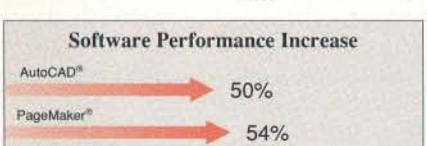
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OS/2 Coverage: Excellent or What?

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John Caprioli
Worcester, MA

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SPECIAL REPORT

Windows vs. OS/2

Windows, OS/2, or NT: How to pick the best operating system for you.

FEATURING

- NT or OS/2: Which one's best for Windows applications?
- OS/2 2.1: A User's Perspective
- Compiler Technology
- Networking with Windows and OS/2

Jon Udell's November article "Is There a Better Windows 3.1 Than Windows 3.1?" sums up the new direction BYTE is taking in its perennial attack on OS/2. The appearance of NT as a white elephant means OS/2 can no longer be dismissed for requiring 8 MB of RAM and lots of disk space. Comparisons must now be sought with Windows 3.1.

Windows 3.1's background processing makes a system jitter like a chicken with its head cut off; OS/2's multitasking capabilities purr like a kitten. As for NT, OS/2's object orientation gives me the power to tailor my environment to my personality, and not to that of Bill Gates.

Mark Heseltine
London, U.K.

We don't think we've been attacking OS/2. In fact, we voted OS/2 2.1 a BYTE Award of Excellence (see last month's issue).—Eds.

It's about time we began to look beyond mighty Microsoft in the operating-system arena. For two years, Microsoft has been telling us everyone needs a multitasking, multithreaded, protected, 32-bit operating system. But when NT went from a desktop operating system to a network server, Microsoft told us we don't need that power "quite yet." When Chicago comes out, suddenly we'll need that power.

I say we have that power now. It's called OS/2, it's here, and it works. Most magazines are so enamored of Microsoft they won't look at anything else.

Todd Louis Green
Silver Spring, MD

In a nutshell, I don't believe you. Udell's Windows-OS/2-Windows NT comparison claims NT has disk I/O speeds more than twice those that DOS-based Windows or OS/2 can deliver. Something's wrong here.

Disk I/O is mature in operating systems and approaches the maximum throughput the hardware can deliver. Am I to believe Microsoft has suddenly developed a manner of handling disk I/O that blows all previous methods out of the water—and then didn't trumpet this new method to the stars? I think not. When something looks too good to be true, it usually is. I think someone needs to substantiate your results, before I start to believe some PR person sent you a case of your favorite wine.

Peter Skye
Glendale, CA

NT can't make disks transfer data faster, but its unified cache manager—which dynamically allocates memory not claimed by the operating system or by applications to the caching of all local and redirected file systems—does a terrific job. You can statically allocate big chunks of dedicated RAM to the Windows or OS/2 disk caches, but then applications can't share it.—Jon Udell

Books on CD

I welcomed Hugh Kenner's Commentary in the November issue. Books are often hard to read on CDs. I also find it annoying that I can't scribble notes in the margins and that CD-ROM publishers often fail to include page numbers or complete bibliographic information. This makes academic citation all but impossible.

On the other hand, cutting and pasting makes quoting large tracks a breeze, and the low cost of CDs is a boon to students like myself.

Wade Riddick
Austin, TX

I was appalled by Kenner's claim that "most books are better left on paper" (than put on CD-ROM). Is the day far off when the cost of a library on CD is less than a comparable one in text? That day is here for subscribers to periodically updated professional libraries in law and medicine. The issue for "the future" is not printed versus electronic books, but locally stored (CD-like) versus transmitted (superhighway) books. I have some nice slide-rule company stock for naysayers.

R. I. Feigenblatt
Arden, NC

This Office Needs Another Subscription

Here's a game based on Jerry Pournelle's column: When a new issue of BYTE arrives at the office, volunteers each take a turn to find the first instance of *alas*. (As in, "Alas, the computer didn't work.") The player with the shortest time wins and gets priority to the office's lone copy.

Bill Clark
Sheboygan, WI

Fixes

We inadvertently omitted mentioning the company (Caere, Los Gatos, CA) in a December 1993 What's New write-up of OmniScan, its 400-dot-per-inch hand-held scanner.

In "Point-and-Click Presentations" (November 1993), the author incorrectly said that Harvard F/X, the bit-map editor in Harvard Graphics 2.0, does not support scaling and cropping of bit-map images; it does.

In "Printers in Transition" (December 1993), we stated that as printer resolution rises, required RAM increases exponentially. The correct mathematical relationship is proportional to the square of the resolution, because as you double resolution, you get four times the data.

The map in the December 1993 Report from Cyprus ("A Market in Transition") was incorrectly identified. According to experts in international relations, the international community recognizes the Republic of Cyprus as a sovereign state and does not recognize two separate states within the island. Most countries (with the exception of Turkey) have not recognized the northern part of Cyprus as a state.

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; send BIX mail c/o "editors," or send Internet Mail to letters@bytepb.byte.com. Letters may be edited.*

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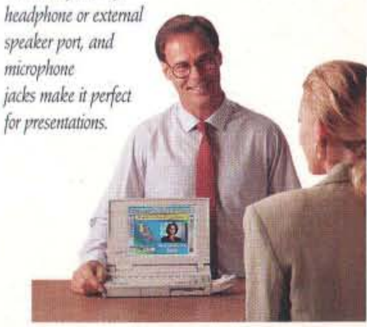

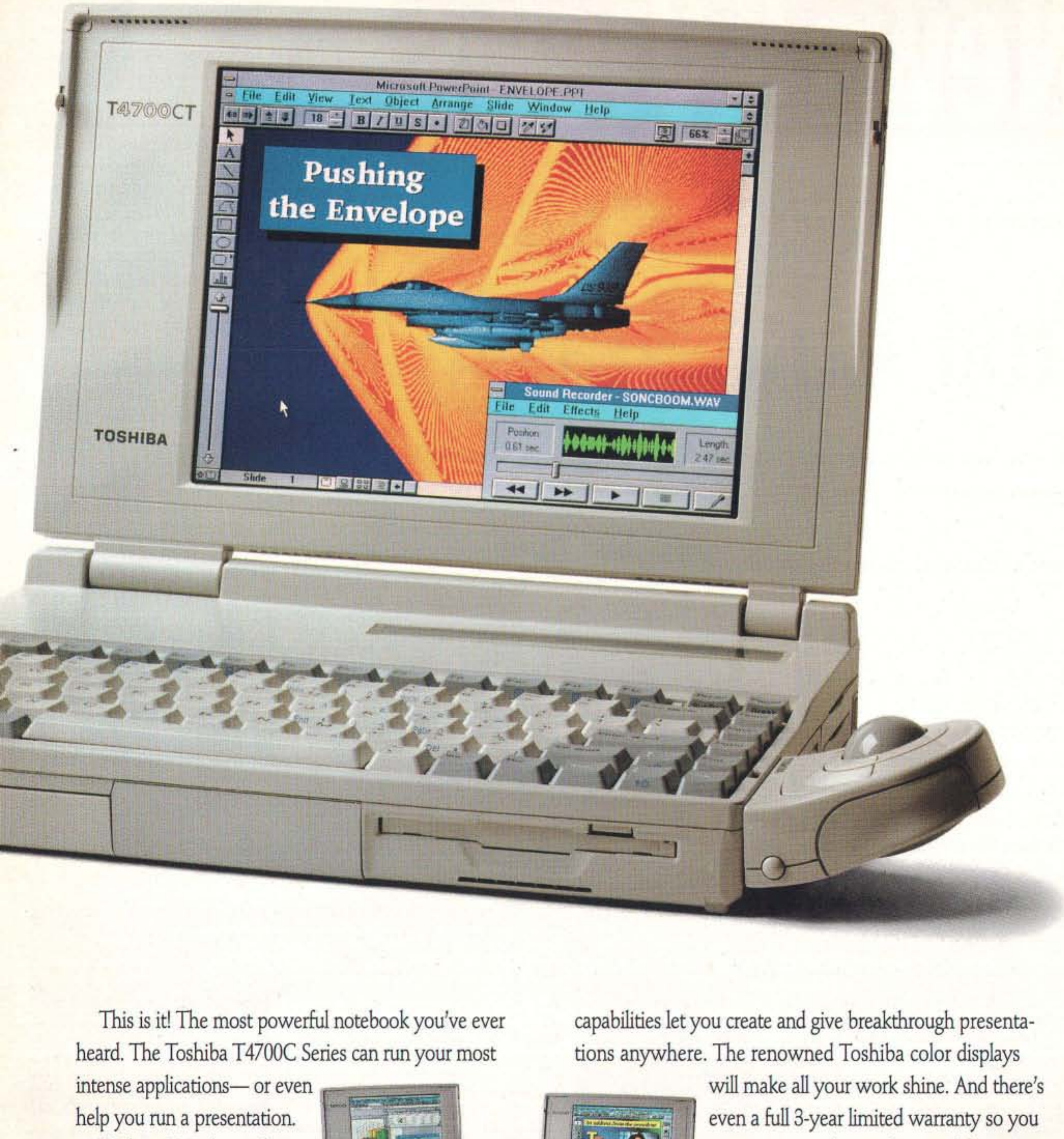
T4700CT
TOSHIBA
Microsoft PowerPoint - ENVELOPE.PPT
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News & Views

COMMUNICATIONS

Just Like Magic?

It will likely take years, but General Magic and its partners want to create a ubiquitous communications infrastructure

BY TOM R. HALFHILL AND ANDY REINHARDT

Today's communications infrastructure is a chaotic mishmash of wired and wireless networks that either aren't interconnected or are linked via clumsy gateways. Business users and consumers who could benefit from ubiquitous communications have trouble dealing with all the different platforms, topologies, and protocols. Developers who could provide solutions face formidable obstacles because there's no unifying technology to bridge the gaps. Although users can access a wealth of on-line information and services, they must know where to look and be willing to master different user interfaces, which tend to be rigidly text-based and command-line-oriented.

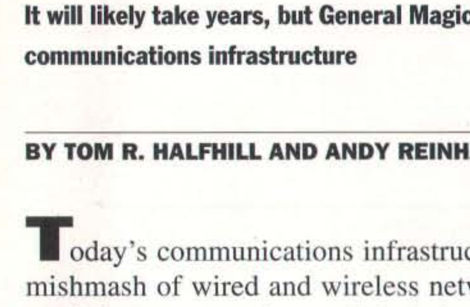
After four years in development, a suite of technologies designed to profoundly alter this structure is coming to market. The technologies were developed by General Magic (Mountain View, CA), a start-up company that counts Apple, AT&T, Matsushita, Motorola, Philips, and Sony among its partners. The pieces include Telescript, a communications-oriented programming language for creating distributed applications and intelligent agents; Magic Cap, an object-oriented operating system designed for PDAs (personal digital assistants); and a new GUI that's a radical departure from the Lisa-Macintosh-Windows model of the 1980s.

All these technologies will start appearing in the next few months, embedded in devices from General Magic's partners and licensees. At least two firms—Sony and Motorola—plan to introduce their PDAs by midyear. Initially, they will be based on Motorola's 68300 "Dragon" microprocessors, but Magic Cap is being ported to other chips, including Intel's 80x86 and the PowerPC.

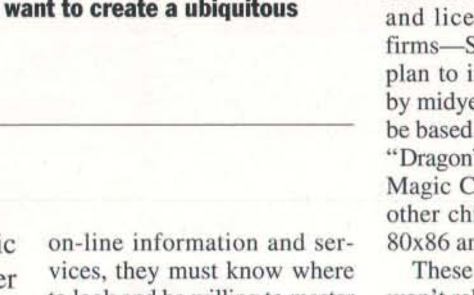
These new PDAs probably won't rely as heavily on handwriting recognition as Apple's MessagePad and Tandy/Casio's Zoomer. Instead, they'll be more communications-oriented, with integral wireless and cellular-phone capabilities.

Telescript, a communications-oriented programming

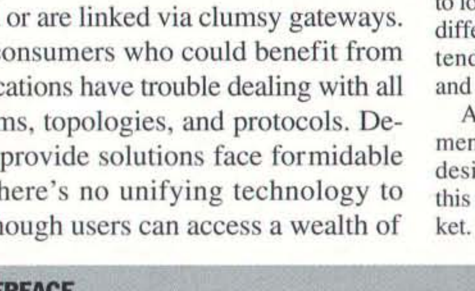
THE MAGIC CAP INTERFACE



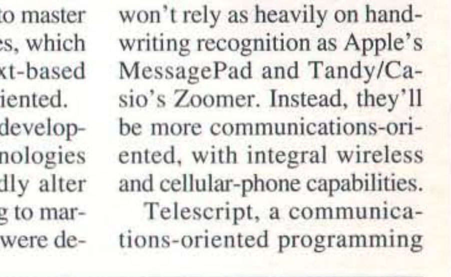
No matter where you are in Magic Cap, you can call someone, send a message, or look up someone's address.



Magic Cap's desk metaphor lets you file documents in a drawer.



Magic Cap may resemble a cartoon, but it's simple enough for casual users and is a radical departure from today's GUIs.



☑ 3. When any message arrives, play the Magic sound.

☑ 4. When a confidential message arrives, file it in the Personal folder.

☐ 5. When a message with an offer stamp arrives, file it in the trash.

☑ 6. When an urgent message arrives, post an announcement saying "Urgent message arrived!".

Magic Cap provides you with a set of editable rules for handling incoming messages.

language comparable to C or Pascal, will let developers create network-independent intelligent agents and distributed applications. Some of these applications, in turn, may be tools that let ordinary users create intelligent agents without programming. What PostScript did for cross-platform, device-independent documents, Telescript aims to do for cross-platform, network-independent messaging. General Magic hopes Telescript will become a lingua franca for communications.

Because Telescript is a portable language that executes atop a run-time interpreter, applications can run without recompilation on any supported platform or network, not just Magic Cap. Equally important, Telescript shields programmers from many of the underlying complexities of network protocols and directory services, just as the Windows API and Mac Toolbox shield programmers from the complexities of window management, graphics, and device I/O. General Magic is widely licensing Telescript to vendors for many different purposes.

For example, AT&T is now using Telescript to build a new E-mail service that will support rich messaging and data interchange. The new service will offer gateways to existing services, such as CompuServe, America Online, and AT&T's own EasyLink. Because Telescript is also being adopted by other General Magic partners, it has an opportunity to become the standard middleware for all communications-centric applications.

Like Telescript, Magic Cap will appear on PDAs from multiple vendors, including General Magic's partners and licensees. Magic Cap isn't just an operating system for PDAs, however. It could also be used in devices like fax machines, smart phones, or even TV cable boxes.

Magic Cap represents General Magic's bid to take GUIs to the next conceptual level. While today's environments protect users from many details of the hardware and operating system, Magic Cap goes even further. For instance, no longer must users understand the differences between executable and nonexecutable files, directories and subdirectories, physical and logical drives, or filenames and extensions.

The new GUI was invented by ex-Apple engineers and General Magic cofounders Bill Atkinson and Andy Hertzfeld. It may appear as absurd and cartoon-like to experienced computer users as the Lisa's GUI did in 1983, but it's intended to make personal computing accessible to the millions of people who otherwise might never buy a computer. Although Magic Cap is optimized for the small LCD screens of PDAs, it will also run on desktop computers, either as the primary GUI or atop an existing one (much as Apple's At Ease runs atop System 7), such as the Mac or Windows.

Magic Cap already runs on the Mac, and it can take advantage of the higher resolution and better color available on the screens of desktop computers. It has the potential to become a leading desktop GUI for users who are technically unsophisticated. Even if it fails in this attempt, it will likely influence the future evolution of other user interfaces.

General Magic has many potential competitors. Magic Cap goes up against operating systems like Windows for Pens/Winpad, PenPoint, Newton Intelligence, GeoWorks' GEOS, and DOS running on pocket PCs. Microsoft is promising users and ISVs (independent software vendors) "Windows everywhere," but it remains to be seen how the look and feel of Windows will be preserved across disparate platforms and devices. GEOS does a better job of bridging these differences by decoupling the user interface from the application code, and it's already showing up on PDAs from Tandy, Casio, and Sony. The fate of the MessagePad is unclear.

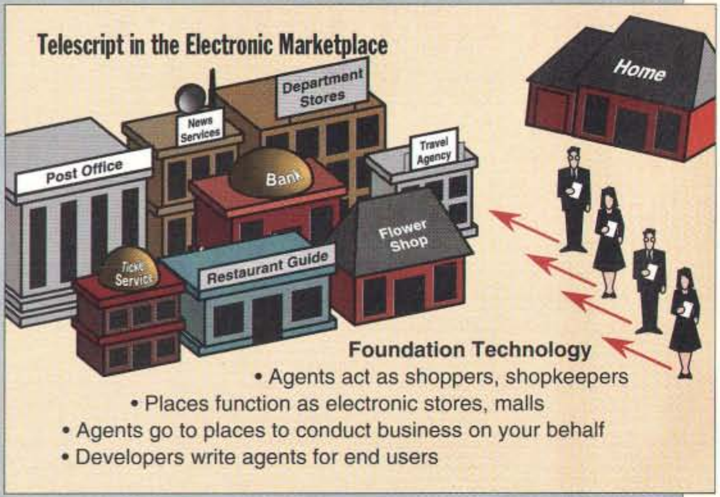
The competition for Telescript is not as obvious. Its closest rivals appear to be RPC (remote procedure call) mechanisms like the OSF's (Open Software Foundation's) DCE (Distributed Computing Environment) and Sun's DOE (Distributed Objects Everywhere), as well as store-and-forward architectures like Microsoft's MAPI (Messaging API).

The obstacles to General Magic's success may appear daunting, but General Magic is not your typical start-up company. Its partners include some of the biggest players in the worlds of computing, communications, and consumer electronics, and it's loaded with top-notch engineers who have been given a clean slate to reinvent traditional approaches to ubiquitous worldwide communications.

AGENTS ON THE LOOSE

Telescript, General Magic's communications-oriented programming language, lets developers write tools that permit casual users who know nothing about programming to create intelligent applications that seek out and retrieve important information. What kinds of applications does Telescript enable?

Think how PostScript made it easy for nonprogrammers to enrich documents with new data types—such as graphics, color, fonts, and photos—and then reproduce those documents on a wide variety of output devices without writing—or even seeing—any PostScript code. Telescript hopes to do the same thing for communications. Users could send E-mail enriched with graphics, photos, video clips, voice annotation, encryption, and scheduling information while avoiding the chaotic details of file formats, network protocols, service gateways, and other technical exotica.


Telescript in the Electronic Marketplace

Foundation Technology
- Agents act as shoppers, shopkeepers
- Places function as electronic stores, malls
- Agents go to places to conduct business on your behalf
- Developers write agents for end users

The key breakthrough: Telescript messages are smart objects that know what to do and where to go. Unlike today's E-mail messages, which are merely files of ASCII text and binary attachments that flow through a pipe, Telescript agents are self-contained units. They navigate WANs (wide-area networks) on their own, correctly present themselves when they arrive at their destinations, and support flexible capabilities such as automatic forwarding or return receipts, regardless of the platform.

For example, businesspeople could create or buy custom news-clipping agents ("Fetch me every AP story on oil exploration") and stock-market agents ("Send a buy order to my broker if Intel's stock dips below 100"). Newspapers could sell on-line classified ads and then freely distribute agents to help consumers find what they want.

The open specifications for Telescript may enable a cottage industry of freeware and shareware agents customized to perform a limitless number of specialized tasks. —Tom R. Halfhill and Andy Reinhardt

NEW PRODUCTS

Best of Comdex Awards

At last fall's Comdex, BYTE editors worked morning, noon, and night in picking the best products and technologies exhibited at the show. Winners and finalists are listed below.

Best of Show: Simon, a personal communications device, took top honors at the show (see the related story on page 28).

Most Significant Technology: Top honors went to the P1394 High-Performance Serial Bus draft standard, a new technology that should have a profound effect on computers and peripherals, as well as home electronics and industrial equipment. This bus interface is designed to be an inexpensive, universal interconnection for linking computers with hard drives; CD-ROM drives; printers; scanners; and consumer products like digital VCRs, TVs, and stereos at data transfer rates of up to 400 Mbps. The standard is being developed by a committee within the IEEE. Companies receiving the award that participated in P1394 development included Adaptec, Apple, IBM's PC Company, Maxtor, Texas Instruments, and Western Digital.

Finalists in this category were µPol (pronounced micropol), from VRex (Hawthorne, NY); and Raven, from Intergraph (Huntsville, AL). The VRex technology includes hardware and software for inexpensively displaying 3-D stereoscopic images. Raven, a software/hardware combination, is designed to bring high-speed audio and video to Windows NT.

Best Portable: Simon won this. Finalists included the highly expandable, luggable PAC-586 Pentium system from Dolch (see the related story in this section), and Irvine, California–based Toshiba's Portégé T3400 and T3400CT subnotebooks.

Best System: The Quadra 610 with its DOS-compatible card took top honors (see the January News&Views). Finalists were the Express RISC server from NEC Technologies (Boxborough, MA), a dual-processor system that's based on NEC's VR4400MC Mips processor; and DEC (Maynard, MA), which has introduced its DECpc XL series of modular 486- and Pentium-based PCs that will let you upgrade to the company's Alpha AXP CPU technology via a daughtercard.

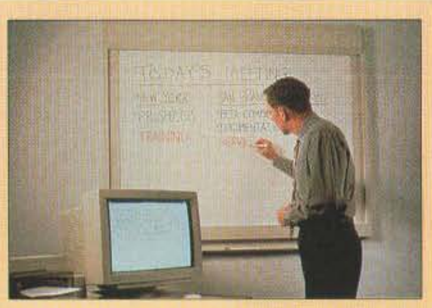
Best Connectivity/Hardware: Largo, Florida–based AT&T Paradyne's DataPort 2001 Multimedia Communicator, a modem-size box with bundled modem/fax software and Data Beam's FarSite shared whiteboard program, lets you simultaneously talk and send and receive still images, graphics, and data on the same regular telephone line. Finalists included Solflower Computer (San Jose, CA), which developed a multihost controller that lets up to 16 Sun workstations share information at 8.3 MBps. Artisoft's (Tucson, AZ) Simply LANtastic, the other finalist, includes a scaled-down, simplified version of LANtastic 5.0 and ingenious self-terminating Ethernet adapters that can be daisy-chained and disconnected without interrupting the network.

Best Peripheral: SyQuest's SQ1080 offers the first PCMCIA removable hard disk cartridge drive. Finalists were DSP Solutions' (Palo Alto, CA) portable 16-bit PCMCIA sound card and Philips Consumer Electronics' Brilliance 2130, a 21-inch digital monitor.

Best Connectivity/Software: DEC's LinkWorks software lets workgroups share information and collaborate over networks. Finalists were Visual Voice, a Visual Basic custom control from Stylus Innovation (Cambridge, MA), and BW-Server, from Raleigh, North Carolina–based Beame & Whiteside. BW-Server provides NFS (Network File System) functionality to an Intel-based PC without requiring a Unix-based machine to act as an NFS server.

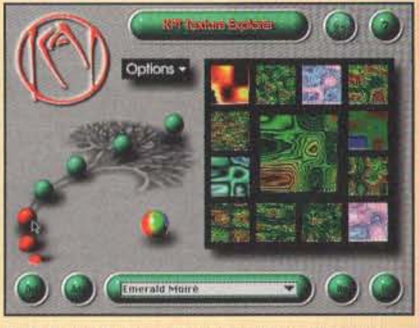
Best Multimedia Hardware: Austek Microsystems' A1060 was named the winner (see the related story on page 28). Finalists included Fast Electronic U.S. (Natick, MA), which offers a video overlay, frame grabber, TV tuner, and video-editing system on one card with software for $549, and Microfield Graphics' (Beaverton, OR) Softboard.

Best Multimedia Software: Ultimedia Video IN/2 ($199) for OS/2 2.1 from IBM Personal Software Products converts video input to Indeo or IBM Ultimotion format. Finalists were Lotus Development's ScreenCam (see the story on page 28), and Tempra Producer Pro, a $99 Windows-based modeler and rendering program from Mathematica (Lakeland, FL).



Microfield Graphics' Softboard is a $2995 peripheral that looks like an everyday whiteboard but displays information that you write simultaneously to a Mac or PC connected via a modem and phone lines. Softboard can greatly enhance a remote audioconference.

When system manufacturers include the drive in their desktop and notebook computers, SyQuest (Fremont, CA) expects the price for end users to be less than $1 per megabyte. The drive accepts rugged, removable 60- and 80-MB cartridges.



Kai's Power Tools, which works with any Windows application that supports Adobe Photoshop plug-in extensions, simplifies many of the complex operations in applying special effects to an image. The Texture Explorer lets you generate textures that go far beyond traditional textures like marble or wood.

Best Printer: QMS (Mobile, AL) and its 2001 Knowledge System ($3999) took the top award in this category. QMS's system is based on Windows 3.1, and it combines a copier, fax, scanner, and laser printer. Finalists were the 360-dpi Canon (Costa Mesa, CA) $649 BJC-600 color ink-jet and LaserMaster's (Minneapolis, MN) $19,995 Digital Color Printer.

Best Software: Kai's Power Tools from HSC Software (Santa Monica, CA) won. Finalists were WizRule, a program developed by Rational of Tel Aviv that discovers exceptions and unknown rules in a database, and IBM's Personal Dictation System, which can handle up to 70 spoken words per minute.

—Dave Andrews

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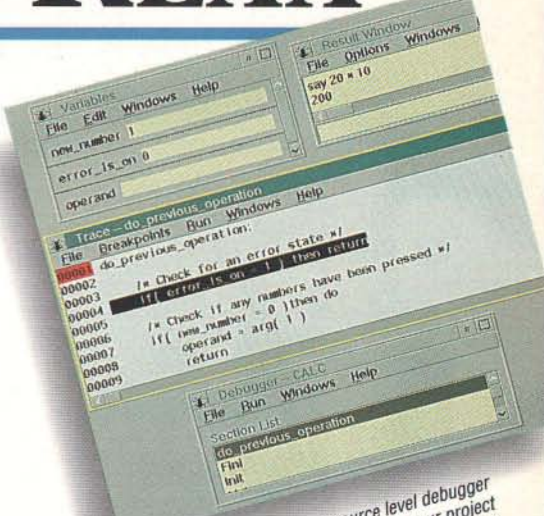
ntegrated Development Environment Build, test and debug your application ithout leaving the development environment. Then package your application as an EXE file or M macro for royalty-free redistribution. The power of the integrated development environment d debugger can also be used with your existing REXX applications.

owerful Open Environment Enjoy the simplicity of event-driven rogramming together with the global editing capabilities essential for professional project anagement. WATCOM VX•REXX is open and extensible through IBM's bject oriented System Object Model (SOM) technology. You n access all standard REXX API's including DB2/2, ecause VX•REXX is based on the OS/2 2.x andard system REXX.

nteractive Debugging an error occurs at run-time, VX•REXX will splay a traceback pinpointing the source ne where the error occurred. A simple click the mouse will return you to the source edit indow to correct the error. The built-in teractive source-level debugger lets you set reakpoints, step through code and watch riables to track down complex problems.

uild Professional Applications ATCOM VX•REXX allows you to leverage key S/2 features to create professional applications. uild applications that dynamically create and modify UA'91 screen objects at both edit and run-time, and clude OS/2 style help and hints.

reate Multi-Threaded Applications very VX•REXX application contains multiple threads. One thread mains responsive to user input while others continue processing. addition, VX•REXX provides the ability for advanced plications to easily use additional threads.



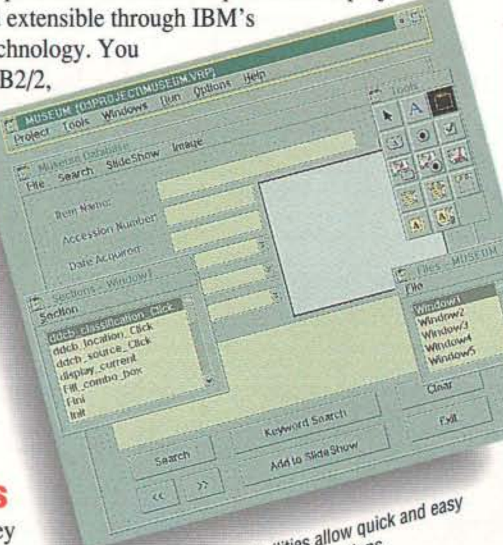
```
say 20 * 10
200
```

```
do_previous_operation:

    /* Check for an error state */
    if( error_is_on = 1 ) then return

    /* Check if any numbers have been pressed */
    if( new_number = 0 )then do
        operand = arg( 1 )
        return
```

The integrated source level debugger simplifies your project development.



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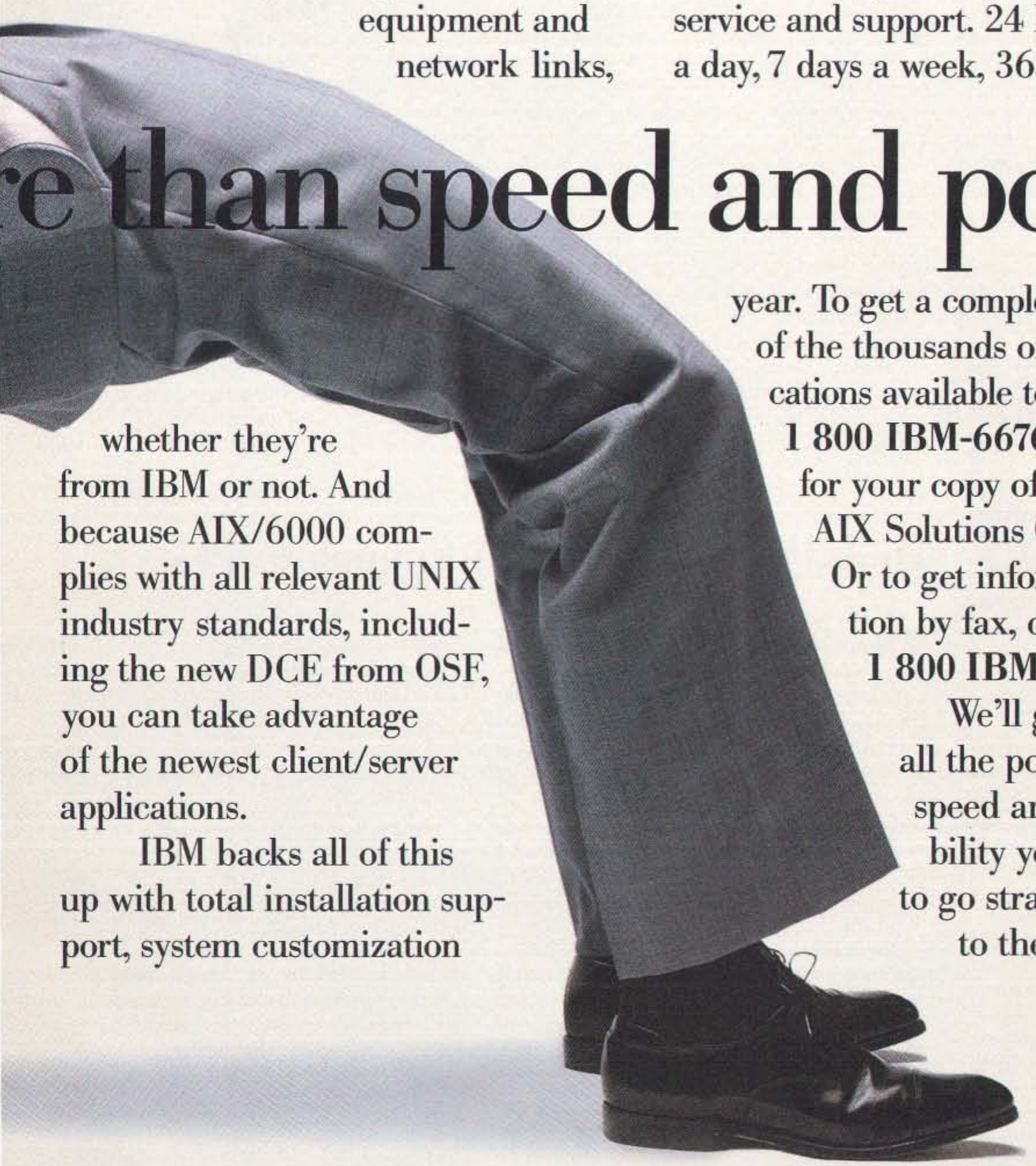

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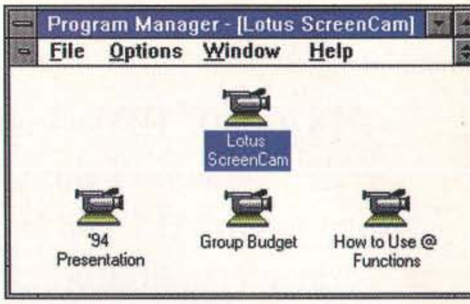
BUSINESS MULTIMEDIA

ScreenCam, Lotus's On-Screen "Tape Recorder"



Too much technobabble and too heavy a reliance on video: Steve Barlow, the product manager for multimedia at Lotus Development (Cambridge, MA), believes that these two obstacles have contributed to the perception by business that multimedia doesn't make you productive and isn't worth the cost. Barlow says if Lotus had originally marketed its flagship Lotus 1-2-3 in the same way multimedia is being promoted today, the company would have pointed at the spreadsheet program and said, "Look at this great technology...look at this great cell engine."

As part of its strategy to deliver business-practical multimedia into the hands of novice computer users, Lotus has introduced ScreenCam, a program for Windows that lets you capture screen activity, cursor movements, and sound into a file that can be integrated as a stand-alone executable file or with any Windows program that supports OLE.

To create a ScreenCam file, you click on a record icon to begin the recording session. As you move the mouse and enter keystrokes, you narrate your screen activity as you speak into a microphone. To play a ScreenCam file, you don't need ScreenCam or the application that created it. ScreenCam does not require a video-capture card (although it does require a sound card). It can create full-screen, full-motion files that can play on a 386-based or higher machine.

Lotus says that ScreenCam is a natural for letting people distribute files that explain a new feature in a program or annotate a word processing or spreadsheet file. A 1-minute ScreenCam file will typically consume about 1 MB, most of which is due to the sound, Barlow says. Lotus is investigating several compression alternatives.

ScreenCam will be bundled first in Lotus 1-2-3 release 4/ Multimedia Edition, but Barlow says the company plans to release it with future versions of Lotus Notes and SmartSuite. A stand-alone version expected in the first quarter will probably sell for under $100.

—D. A.

SIMON SAYS: COMMUNICATE

IBM and partner BellSouth have introduced a personal communication device that combines a cellular phone, fax, E-mail, cellular paging, and several personal productivity applications in a system that weighs just 18 ounces.

BellSouth, which is distributing the product for IBM, will introduce Simon ($899, call (800) 746-6672) first to the central Florida region and then to other markets in the U.S. Nicole Lipson, manager of media relations at BellSouth Cellular, says the company expects that Simon will be available nationwide by April. IBM is evaluating whether it will release Simon to international markets.

BellSouth quotes a battery life of about 8 hours while in standby mode and about 1 hour during continuous talking or data transmission. A backlit LCD lets you access Simon's communications, calendar, appointment, calculator, paperless notepad, keyboard, and address book applications using a plastic pen or your finger. A built-in 9600-bps fax modem lets you send or receive faxes of up to three pages. An optional PCMCIA pager card will let you receive alphanumeric pages.

—D. A.

GRAPHICS/ENTERTAINMENT

High-Performance 3-D Coming to PCs

Applications like 3-D model animation, stock-market visualization, and other high-end programs usually found only on expensive workstations should start appearing this year on less expensive 80x86-based PCs. Thanks to board-level OpenGL graphics accelerators coming soon from companies like Austek Microsystems and DuPont Pixel, system vendors will be able to build relatively inexpensive PCs capable of delivering workstation-like performance on applications running atop OpenGL.

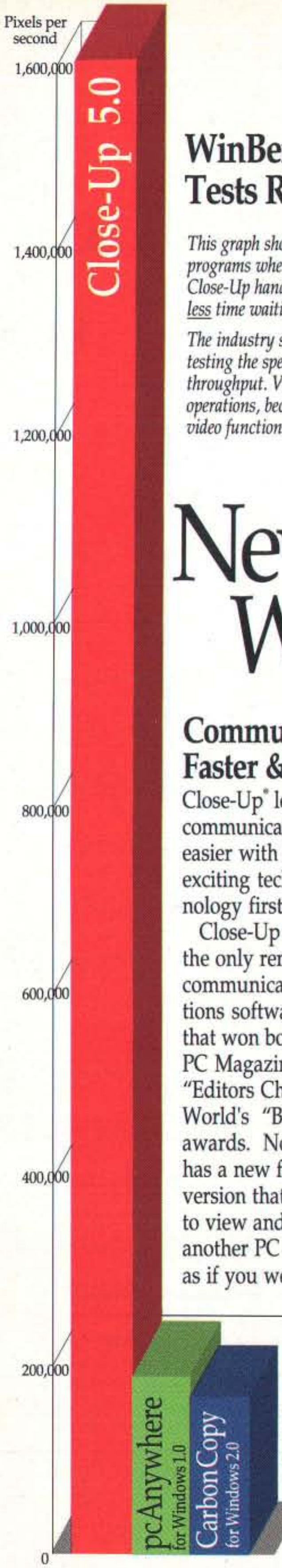
Silicon Graphics' OpenGL API makes it easier for developers to program such applications and creates the hooks for hardware accelerators. These inexpensive graphics accelerators, when working side by side with CISC or RISC processors and OpenGL-based applications, will make it possible to deliver a 3-D processing platform at an affordable price.

At Comdex, Austek Microsystems (Fremont, CA) introduced its A1060 graphics accelerator, which the company expects to begin production on in the first quarter and sell for about $100 each to OEMs in "moderate" volume. The goal of the company, according to Chris Russell, marketing manager of graphics products at Austek, is to provide a low-cost platform that allows the easy porting of high-end applications to higher-volume platforms. Such graphics accelerators can off-load the central CPU from having to write pixels to a frame buffer and shade them and let the main CPU and FPU concentrate on true math operations (e.g., matrix transformations).

DuPont Pixel's Glint chip will accelerate OpenGL 3-D graphics running under Windows NT and Unix. Osman Kent, executive vice president of R&D at DuPont Pixel (San Jose, CA, and Egham, U.K.) says the Glint chip will deliver advanced graphics performance on machines ranging in price from $3500 up to $35,000. Glint is not expected to start sampling until the middle of the year.

Austek's Russell cautions that these new 3-D platforms are not restricted to the technical market. "Developers of entertainment and education applications may also see this platform as a very attractive one to write 3-D programs," he says. "As board-level products begin to emerge based on our technology and Silicon Graphics' OpenGL, then the entertainment developers would see this as a very attractive combination to write high-performance, low-cost 3-D games."

—Dave Andrews and Dom Pancucci



WinBench scores (average of 10 runs):
Close-Up 1,613,118
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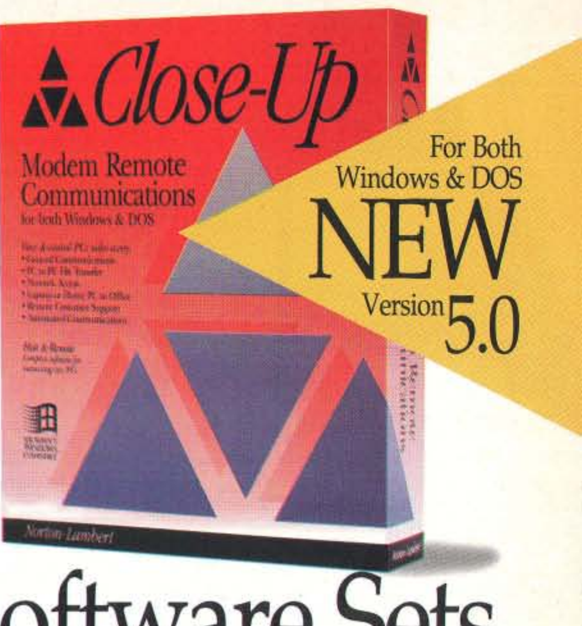
WinBench™ 3.11 by Ziff-Davis Labs Tests Remote Windows™ Speed

This graph shows the speed of the three leading remote control programs when transferring Windows screens. As you can see, Close-Up handles more pixels, faster, meaning you spend less time waiting for Windows screens.

The industry standard test, WinBench 3.11, is perfect for testing the speed of remotes. It is an accurate measure of video throughput. Video throughput is the limiting factor in remote operations, because remote programs must transmit Windows video functions from one PC to the other.



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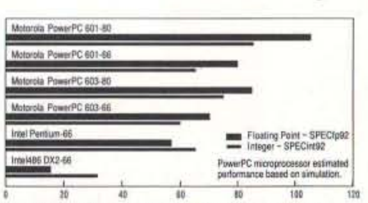

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PowerPC microprocessors. Changin

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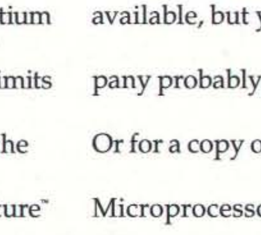

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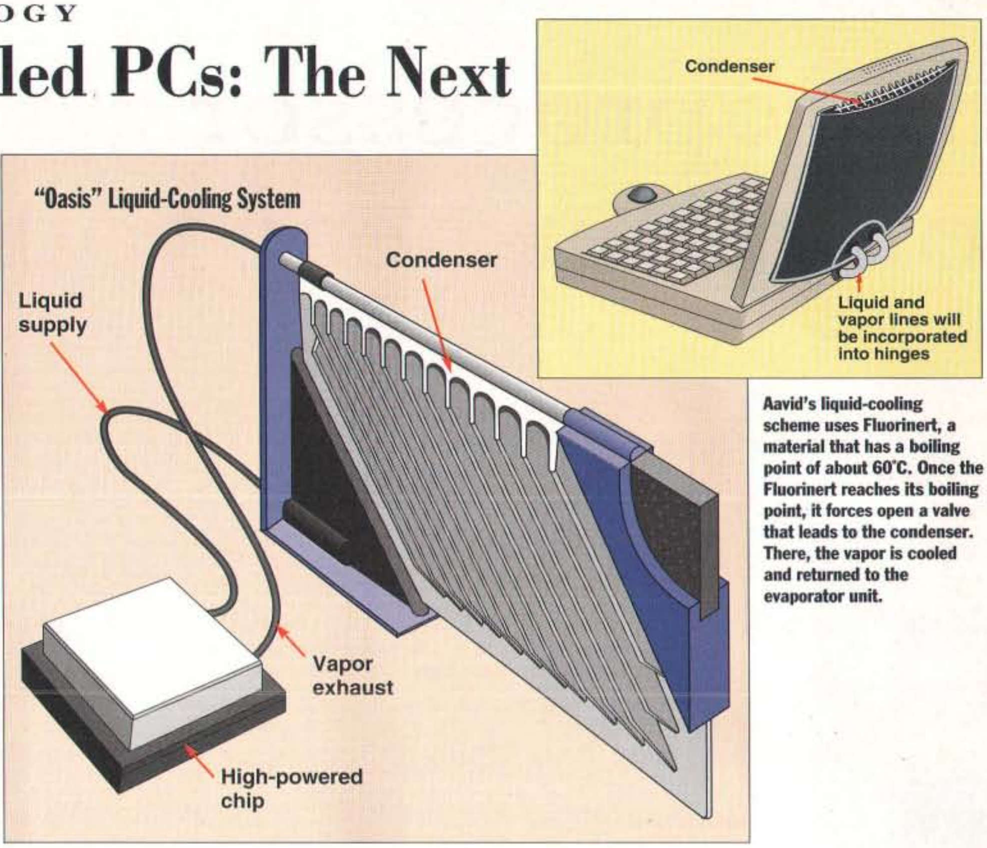
NEW TECHNOLOGY

Liquid-Cooled PCs: The Next Hot Thing?


"Oasis" Liquid-Cooling System

Aavid's liquid-cooling scheme uses Fluorinert, a material that has a boiling point of about 60°C. Once the Fluorinert reaches its boiling point, it forces open a valve that leads to the condenser. There, the vapor is cooled and returned to the evaporator unit.

With chips like the Pentium and DEC's Alpha, the power of the mainframe has indeed arrived on the desktop, but you probably didn't expect the mainframe's cooling system to come along for the ride. However, that's exactly what a New Hampshire company is working on: liquid-cooling systems for desktop PCs and even laptops and notebooks. Unlike the fans currently used to cool desktop PCs, the liquid-cooling system doesn't draw any power and can have a lower profile than a metal heat sink.

The liquid-cooling system developed by Aavid Engineering (Laconia, NH) works much like an air conditioner or a refrigerator and uses a refrigerant fluid called Fluorinert. Unlike Dolch's liquid-cooling technique, Aavid does not use a heat sink. Aavid's system consists of an evaporator, which sits on top of the microprocessor, and a condenser, which can be as small as 6 by 3 inches. The entire system weighs about 75 grams. The fluid in the evaporator draws the heat from the microprocessor and flows to the condenser, where the heat is dissipated.

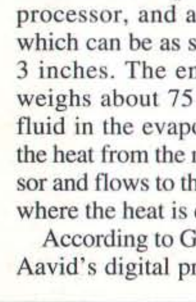
According to Gary Kuzmin, Aavid's digital product director, the first application of the liquid-cooling system will be in desktop machines, because it will be easy to incorporate the system into existing form factors. Laptop and notebook computers would have to be redesigned to accommodate the cooling system, particularly the condenser. Kuzmin says that the condenser can be built into the back of a laptop's display.

Not all CPUs require this much cooling, however. The PowerPC 603, due this year, will likely offer Pentium performance while drawing just 1 to 1.5 W, compared to the 66-MHz Pentium's 16-W power consumption.

Aavid's goal is to produce cooling units priced at around $20 in high-volume quantities. Look for computers using the liquid-cooling system to appear in the second quarter.

—Nicholas Baran

DOLCH ANNOUNCES LIQUID-COOLED PENTIUM PORTABLE



Dolch Computer Systems' (Milpitas, CA) PAC-586, a Pentium-based portable, uses a liquid-cooling technique to eliminate the need for large cooling fans and big heat sinks. Dolch's liquid-cooling technique, which the company uses in its Mach portable computers, uses a combination of a fluorocarbon gel and a heat sink, according to Steve Fritz, spokesman for the company. As the Pentium chip gets hot, heat is conducted through the gel to a heat sink that transfers the heat throughout the metal skin of the portable's inner chassis. The PAC-586, which starts at about $6000, is designed for people who need a highly expandable, luggable PC. —D. A.

Superservers Everywhere

Companies like ALR, AST, Compaq, and Dell, along with IBM, NetFrame, Sequent, and Tricord, are all selling *superservers*, machines that often differ widely in terms of supported operating systems and maximum number of CPUs. What about Cray Research? A company known better for its supercomputers than for scalable servers is actually the company that holds the trademark on the name *superserver*. Yet it wasn't until last fall that Cray's subsidiary, Cray Research Superservers (Beaverton, OR), released a SPARC-based superserver called the CS6400 that will compete with its superserver rivals in commercial markets.

Christopher Willard, manager of high-performance technologies at IDC in Mountain View, California, says that "this system will compete in two areas. One is for technical computers with RISC processors that can run the same software you can run on the desktop. That market includes IBM, Digital, Silicon Graphics, and HP. The other market is the Unix database market, which includes, on the commercial side, Sequent, Pyramid, and others." The new system can have up to 64 CPUs and will be priced starting at $335,000.

—Anne Fischer Lent

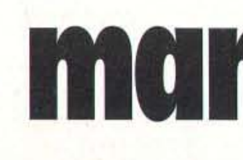
At $345 it doesn't pay to buy dumb.

New Compex TP3000 manageable 6-port hub.

Dumb hubs are, well, pretty dumb. But intelligent hubs cost too much. Now there's an alternative. New Compex TP3000™ modular, manageable 6-port hub system.

At $345 it's a pretty smart solution for a dumb price.

Stack the TP3000 in groups of four practically indefinitely. Any two TP3000s may be connected for 19" rack mounting – all hardware is included. And here's the really smart part. Add the IN3000™ external intelligent module and you get all the hardware for SNMP and HMI hub management of up to 28 ports for only $745. When you figure the math, you're getting an upgradeable hub at under $50/port and a fully managed system for less than $76/port.



TP3000 hubs stack in groups of four.

Basically, with a TP3000 system a network can start small and then grow indefinitely. Two ports at the back of the compact unit let you daisy chain the hub. Six RJ45 connectors and status LEDs are located on the front. One coax connector allows you to easily connect 10 Base T workstations to existing coax networks. Unlike other hubs, the TP3000 doesn't use data ports for expansion, so all ports are available for node connection.

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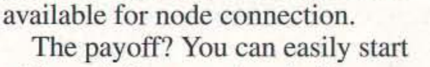

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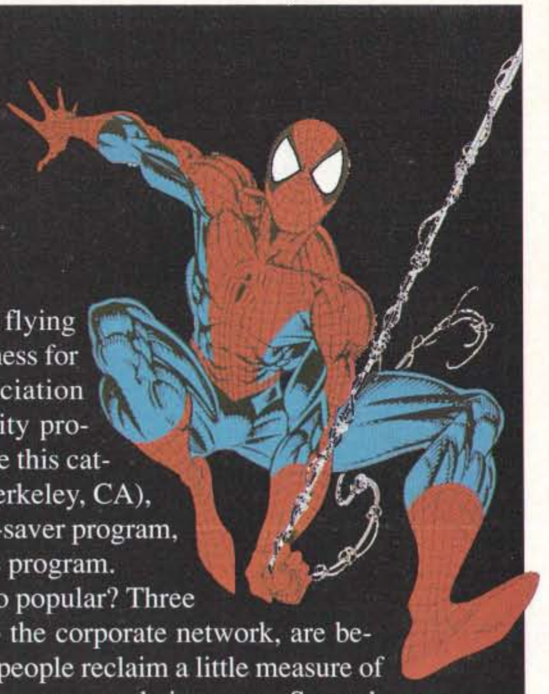
Screen Savers Ad Nauseum

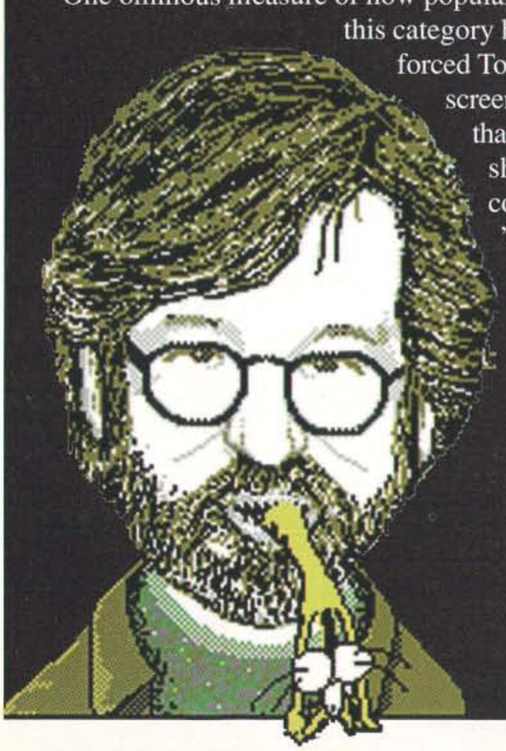


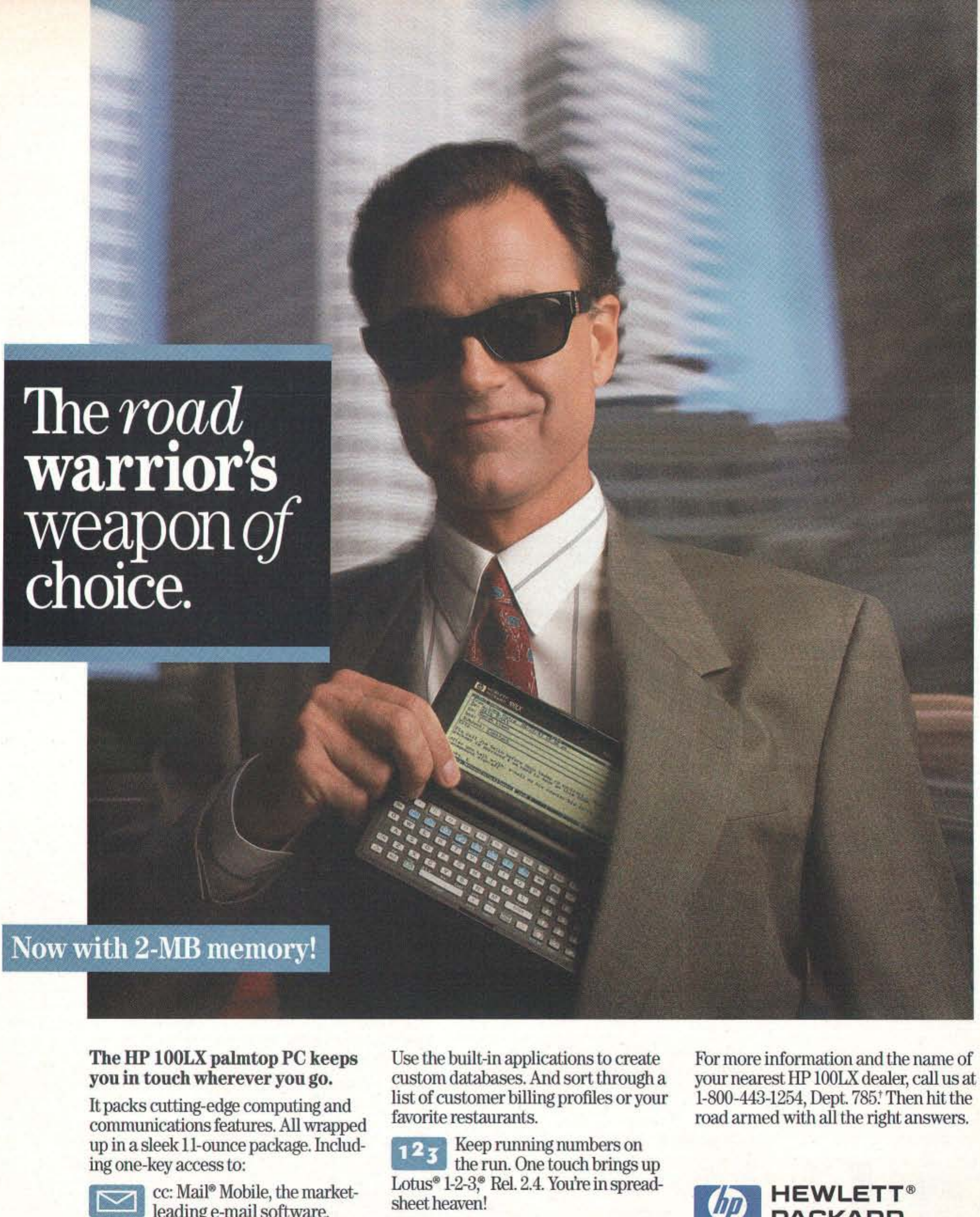
Screen savers, those neat little utility programs that pop up flying toasters, sea horses, and bespectacled cows, have become big business for software companies. Currently, the Software Publishers Association (Washington, DC) tracks screen-saver programs with other utility programs, so it's hard to tell how much revenue this category generates. But Berkeley Systems (Berkeley, CA), developer of the popular After Dark screen-saver program, says it has sold over 1 million copies of the program.

Why has this product category become so popular? Three reasons: PCs, as they become hooked into the corporate network, are becoming less personal, and screen savers let people reclaim a little measure of individuality by letting them put zany characters on their screen. Second, corporations are using programs like Pleasonton, California–based Aristo-Soft's CD-Blaster and Media Blitz 3.0 from Asymetrix, which let them insert their own company logo with a motivational or informational message along with it. Third, most screen savers offer password protection, which adds a measure of security to all this fun. New entries to this category include (clockwise from top right): Marvel Comics Screen Posters (Berkeley Systems); BYTE's screen-saver program; Jurassic Park (Asymetrix, Bellevue, WA); Opus 'n Bill (Delrina, San Jose, CA); and the Snoopy Screen Saver (Image Smith, Torrance, CA).

One ominous measure of how popular screen-saver programs have become is that this category has even made legal news. Berkeley Systems forced Toronto-based Delrina to modify its Opus 'n Bill screen-saver program because the company believed that one module in which the cartoon penguin Opus shoots a flying toaster infringed on Berkeley's copyrights and trademarks. Delrina reissued Opus 'n Bill with the offending sequence removed.

—D. A.

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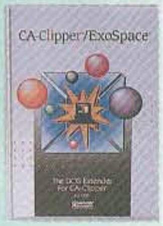

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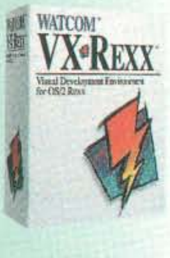

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C/C++32 is a professional, multi-platform C and C++ development system supporting 32-bit extended DOS, OS/2 2.x, Windows 3.x, Windows NT, Win32s, and AutoCAD ADS/ADI. The complete toolset includes: C and C++ optimizing compilers, royalty-free DOS extender with VMM support, licensed components from the MS Windows 3.x SDK, interactive source-level debugger, linker, profiler, Supervisor for executing 32-bit applications and DLLs under Windows 3.x, 32-bit run-time libraries for extended DOS, OS/2 2.x, Windows 3.x and Windows NT, and more.

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MetaWare High C/C++
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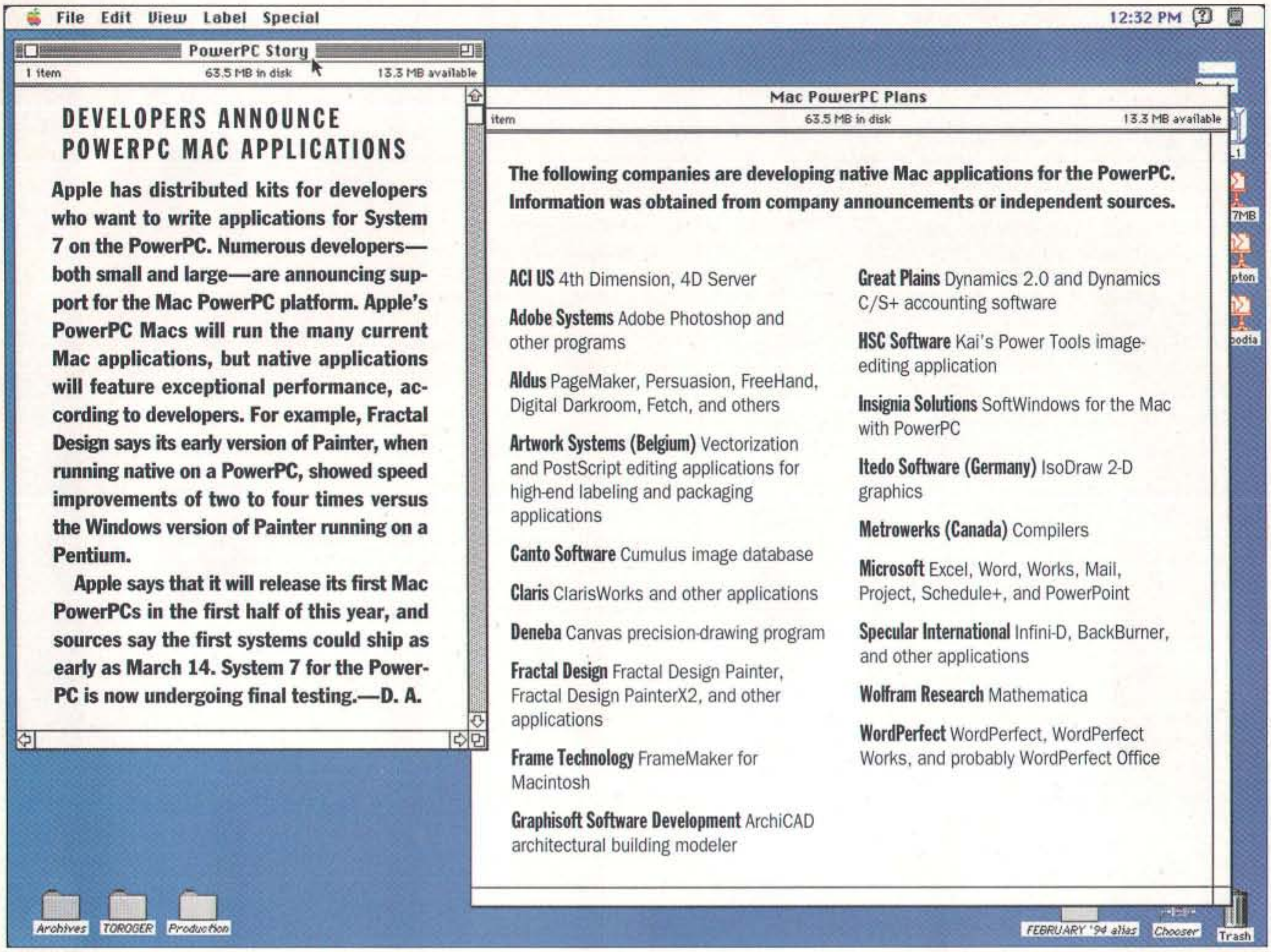


DEVELOPERS ANNOUNCE POWERPC MAC APPLICATIONS

Apple has distributed kits for developers who want to write applications for System 7 on the PowerPC. Numerous developers—both small and large—are announcing support for the Mac PowerPC platform. Apple's PowerPC Macs will run the many current Mac applications, but native applications will feature exceptional performance, according to developers. For example, Fractal Design says its early version of Painter, when running native on a PowerPC, showed speed improvements of two to four times versus the Windows version of Painter running on a Pentium.

Apple says that it will release its first Mac PowerPCs in the first half of this year, and sources say the first systems could ship as early as March 14. System 7 for the PowerPC is now undergoing final testing.—D. A.

The following companies are developing native Mac applications for the PowerPC. Information was obtained from company announcements or independent sources.

ACI US 4th Dimension, 4D Server

Adobe Systems Adobe Photoshop and other programs

Aldus PageMaker, Persuasion, FreeHand, Digital Darkroom, Fetch, and others

Artwork Systems (Belgium) Vectorization and PostScript editing applications for high-end labeling and packaging applications

Canto Software Cumulus image database

Claris ClarisWorks and other applications

Deneba Canvas precision-drawing program

Fractal Design Fractal Design Painter, Fractal Design PainterX2, and other applications

Frame Technology FrameMaker for Macintosh

Graphisoft Software Development ArchiCAD architectural building modeler

Great Plains Dynamics 2.0 and Dynamics C/S+ accounting software

HSC Software Kai's Power Tools image-editing application

Insignia Solutions SoftWindows for the Mac with PowerPC

Itedo Software (Germany) IsoDraw 2-D graphics

Metrowerks (Canada) Compilers

Microsoft Excel, Word, Works, Mail, Project, Schedule+, and PowerPoint

Specular International Infini-D, BackBurner, and other applications

Wolfram Research Mathematica

WordPerfect WordPerfect, WordPerfect Works, and probably WordPerfect Office

Wireless Data over the GSM Voice Channel

MUNICH—For many users in Europe, mobile wireless modems are still a thing of the future. But an inventive German company called TLK Computer (Munich) has a modem that, in connection with a digital mobile phone, is able to transmit data across Europe over a network that is currently used for voice traffic, no matter what your location. TLK's transmitting system works over the GSM-Network (Groupe Speciale Mobile), which is a digital cellular mobile telecommunications service.

Initially, the D-net, which is the GSM-Network's digital cellular network, was designed for speech transmission only. Both telecommunications companies in Germany, Telekom (i.e., German PTT) and Mannesmann, have stated that it is impossible to transmit data via the voice channel of the D-net. But thanks to a special error-correction method and modulation scheme, TLK has achieved what those companies said couldn't be done.

Due to TLK's modulation scheme, to transmit data over the D-channel, you need a TLK GSM modem on both ends of the connection. But it makes no difference if the connection is established between a GSM phone and a regular one. The modems will cost about $1600.

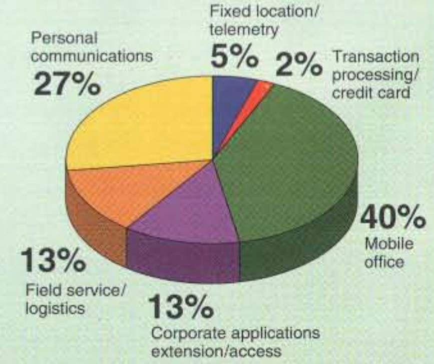
Presently, the modems transmit at approximately 1000 bps. This is because they must share slices of time with other users on the D-net. TLK (+49 89 45 85670; fax +49 89 44 86297) is investigating various compression techniques that it will use in the next version of the modem (due sometime this year).

—Bernhard M. Bradatsch

CELLULAR DATA MARKET SEGMENTATION

The first CDPD cellular-data networks were slated to begin operating in select cities early this year, and CDPD cellular carriers are currently negotiating agreements that will let users transparently roam from one area to another without dropping their connection. At press time, McCaw Cellular Communications' new AirData CDPD network was slated to begin operating in Las Vegas, while GTE Mobilnet planned to take CDPD commercial in San Francisco and Houston in the second quarter. GTE forecasts that by the end of the year, CDPD will be available in about five dozen metropolitan areas in the U.S.

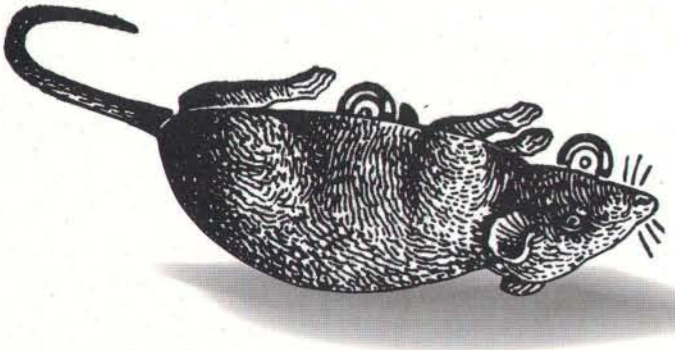
Emerging Wireless-Data Market Segments



Source: McLaughlin & Associates (Schaumburg, IL), 1993

ARISTO

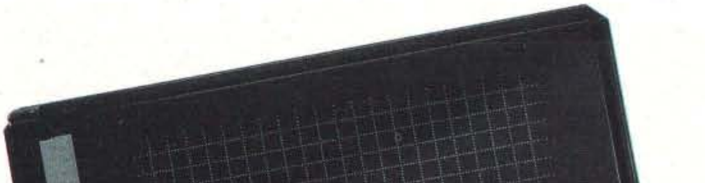
POOR OLD MOUSE.



Most of the time all mice are nice and fine for pointing around. But when it comes to inputting graphics or logos into any application or any CAD package, they are hopeless. They just can't – and so you can't. No way.
Problem? Yes and no. It depends – you may shrug your shoulders and say "Well, I'll never do CAD and I just never want to input any sketches, logos, or photos into my computer anyway." Or – you feel that isn't good enough after all the money you have invested and all the nice things you know you could do today with your own graphics once they were in the computer.

PROBLEM SOLVED.

Here comes the mouse that lets you input all your graphics as well. How?: That's what they all want to know, but we're not telling. Its a new invention. It's a universal combination of a true mouse and an independent manual drawing board that becomes a precision full-featured digitizer tablet once you just place the mouse onto the board. It's all in one or all separate as required. Simply unplug your poor old mouse, plug in our mouse and have the real all purpose input device to your PC always at hand. At a price poor mice can afford too.



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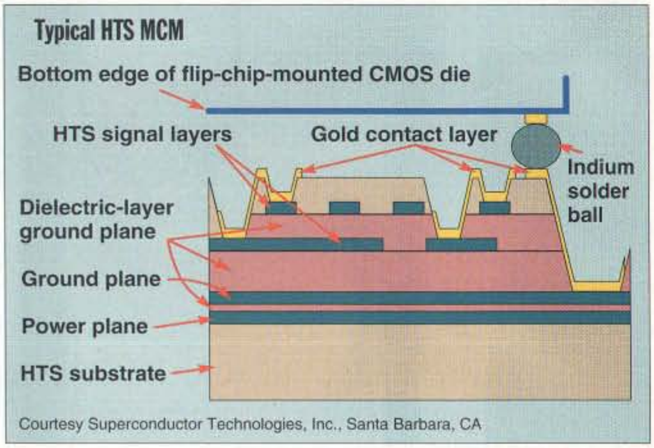
SUPERCONDUCTIVITY

You're Getting Warm if You're Thinking Cool



Courtesy Superconductor Technologies, Inc., Santa Barbara, CA

In HTS MCMs, line widths in transmission lines can be very narrow (i.e., 2 microns), allowing a higher packing density and improved signal transmission over conventional MCMs. Shown here is the module that wires multiple chips together while providing their ground plane and power source.

You won't be working at a cryogenic workstation this year or next. But before the turn of the century, you may be. Recent advances in the field of cryoelectronics, which involves computing at very low temperatures, mean scientists can now evaluate superconductivity at the relatively high temperature range of 77 K (i.e., –356°F) to 135 K. Previous experiments in this area involved working at temperatures in the range of 10 K to 15 K, or about –443°F. By the year 2000, systems could be available that use the following types of HTS (high-temperature superconductive) devices: semiconductors; interconnections between processors, chips, and boards; DRAM chips; and even MCMs (multichip modules).

The benefits of these HTS systems include increases in speed (10 to 100 times), reductions in power (90 percent or more) and reliability (due to their operation with little resistance). According to Joseph Warner, materials electronics engineer at the NASA Lewis Research Center (Cleveland, OH), a refrigerator the size of a Coca-Cola can that can cool these HTS components has already been developed for the space effort.

Scientists have produced successful experimental (and some prototypical) HTS devices for signal processing, ADCs (A/D converters), optical sensors, logic, and memory. Also, analog HTS arrays have been developed for microwave communications and telemetry applications.

The U.S. government's ARPA has a program to develop HTS devices. Among the 20 participating firms are Superconductor Technologies, Inc. (Santa Barbara, CA), Conductus (Sunnyvale, CA), and E-Systems (Dallas, TX). Joseph M. Madden, manager of applications engineering for STI, is one of many who believe that an HTS computing environment is a must.

"HTS interconnects, for example," Madden says, "have demonstrated the ability to pass signals with much greater speed than normal metal interconnects." Madden says that tests performed at STI on a 10-centimeter, 3-micron copper line and an HTS transmission line showed that the HTS line can operate at least twice as fast as an identical copper line.

Claude Hilbert, a member of the technical staff at Microelectronics and Computer Technology (Austin, TX), believes that the gap between microprocessor and memory is where we need HTS technology. He is close to assembling and testing a second-generation HTS hybrid memory (i.e., fast RAM). The ultimate goal of his project is to create a monolithic hybrid chip—a chip with both HTS and semiconductor devices—to be used in high-performance cryogenic workstations.

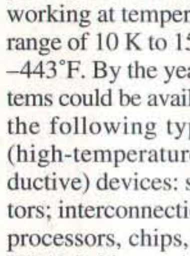
As if it were not tough enough to develop HTS chips, a number of researchers are working on an even more challenging undertaking—creating an HTS MCM. A popular packaging technology, an MCM provides shorter interconnections, high chip densities, and improved IC system performance. HTS MCMs would magnify these benefits.

During the first quarter of 1993, Conductus and STI scientists demonstrated that it is possible to produce a hybrid structure combining active semiconductor and HTS devices on the same substrate. They believe that the successful integration of these disparate yet complementary technologies paves the way for the development of true semiconductive-superconductive hybrid ICs capable of combining the best of both worlds.

Although the benefits of HTS are eagerly awaited by many, not everyone sees HTS devices as tomorrow's technology of choice. The technology has many challenges to overcome. Some computer manufacturers are skeptical that successful solutions will be reached in a timely enough manner to bring relief for some of the difficulties facing the industry. Others have decided to continue using conventional semiconductor devices because of their already outstanding capabilities.

—Janet J. Barron

GEEK OF THE WEEK ON TAPE



Ever listen to one of those 5-minute-long news pieces being broadcast on National Public Radio's *All Things Considered* and wish they were doing an in-depth story on new technology? Well, your wishes are answered.

Each week, Internet Talk Radio offers a 30-minute audio interview with a notable member of the Internet community under the tongue-in-cheek name of "Geek of the Week." You can download this file and play it at your workstation. But if you don't want to download the 45 MB or so of data that is associated with each interview, O'Reilly & Associates sells cassette versions of the interview for $9.95 each. For more information on the radio program over the Internet, send mail to info@radio.com. For information on the tapes, call O'Reilly & Associates at (800) 998-9938 or (707) 829-0515 or send mail to audio@ora.com.

—D. A.

BYTE What's New International

Hardware, Software, and More

486 Notebooks

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High-Resolution Printer Card

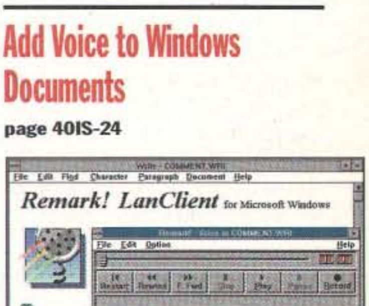
page 40IS-8

Digitizing Tablet for Windows and the Mac

page 40IS-12

Add Voice to Windows Documents

page 40IS-24



Remark! LanClient for Microsoft Windows

Simpact's Remark! LanClient product adds significant value to Microsoft Windows applicatio
by allowing users to create and playback voice messages in documents consisting of text and images.

Economic Information on CD-ROM

page 40IS-16

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Circle 529 on Inquiry Card

What's New International Hardware

ATM PACKET SWITCH

A flexible, high-performance multimedia Asynchronous Transfer Mode switch, the DV2 can support transfer rates of up to 6.4 Gbps. The DV2's ATM protocol supports all traffic types, including voice, data, and video over LANs and WANs.

Jaguar Communications' (St. Albans, U.K.) DV2 provides adaptation interfaces for non-ATM traffic. For example, it integrates various existing traffic, including Ethernet, HDLC data, and frame relay, into a high-speed backbone with a throughput of up to 3.2 Gbps. In addition, the DV2 supports new broadband ISDN applications that require the speed and bandwidth inherent within the ATM infrastructure.

The DV2's (call for prices) architecture allows interconnection over the WAN while simultaneously operating as a LAN hub or distributing traffic at high speeds across a multisite environment. The switch's structure is capable of either 200 or 400 Mbps simultaneous throughput in each direction to each 16-slot controller. You can use a local fiber-slot controller with two 100-Mbps fiber-optic interfaces to interconnect switches over a multisite network or between floors or to connect the switch to high-performance workstations.

Direct Ethernet connectivity lets the DV2 perform routing and bridging functions. You can configure the switch as an Ethernet hub supporting up to 64 Ethernet segments. Each Ethernet adaptation interface comes with four AUI ports. All DV2 cards and power-supply modules can be hot-swapped.

Phone: +44 727 41311; fax +44 727 51245.

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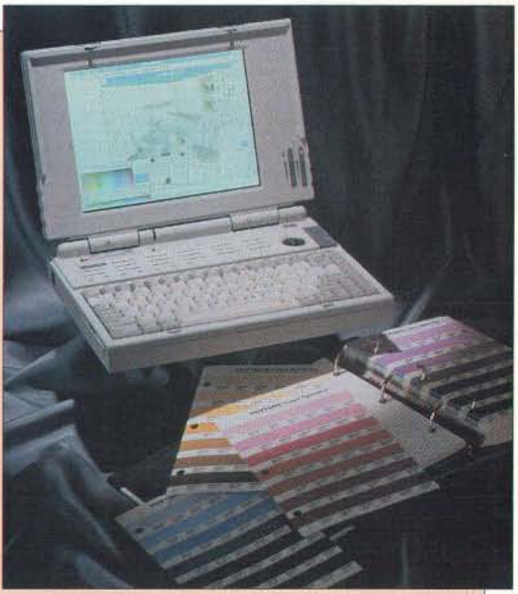
486 NOTEBOOKS



Chaplet Systems offers the HighValue Models of its NBD 486 series of notebook PCs, which are powered by Intel 25-MHz 486SX or 50-MHz 486DX2 CPUs. The color HighValue Model uses dual-scan color passive-matrix technology. Both the color and monochrome models have 512 KB of VRAM, for a resolution of up to 1024 by 768 pixels in color VGA on an external monitor.

The NBD 486 machines (call for prices) come with 4 MB of RAM (expandable to 8 MB); a 10-inch dual-scan passive-matrix color monitor or 10-inch 64-gray-scale monochrome monitor; a 16-mm trackball; an 84-/85-key keyboard with 3-mm travel and inverted T-cursor keys; serial, parallel, external PS/2 keyboard, and external monitor ports; and an auto-sensing AC adapter. Options include an internal fax modem (9600-bps send, 4800-bps receive, and 2400-bps data modem) and an external battery charger for quick recharges of spare batteries.

The hardware-implemented power management functions don't use up any of your 486 CPU's time, and they are also transparent to system and applications software. Battery life is maximized and CPU heat minimized by automatically slowing down the CPU speed whenever the notebook dozes. In addition to dozing, the notebook can automatically sleep or power down the hard drive. It even has a Suspend/Resume button for those times you need manual control.

Contact: Chaplet Systems, Taipei, Taiwan, +886 2 7152355; fax +886 2 7168796.

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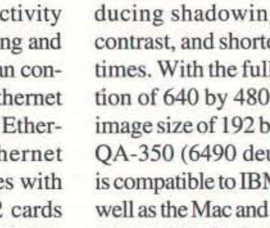
OVERHEAD COLOR DISPLAY



The Sharp Electronics (Hamburg, Germany) QA-350 Overhead Colour Display uses double-scan technology to improve the image quality of STN color LCDs, reducing shadowing, enhancing contrast, and shortening reaction times. With the full VGA resolution of 640 by 480 pixels and an image size of 192 by 144 mm, the QA-350 (6490 deutsche marks) is compatible to IBM standards, as well as the Mac and Apple I graphics modes. Optionally, you can hook up an additional monitor to the overhead panel to make it easier to control the presentation. The panel is controlled with an easy-to-use on-screen menu.

Phone: +49 40 23760; fax +49 40 230764.

Circle 1447 on Inquiry Card.

SEIKOSHA INK-JET PRINTER

The SpeedJet 200 boasts 50-nozzle ink-jet technology, a print quality of 300 by 300 dpi, 180 cps in draft mode, 120 cps in letter-quality mode, a printing speed of 3 ppm, and a maximum printing format of 80 columns at 10 cpi. Seikosha's (Slough, U.K.) SpeedJet 200 (£235) offers semiautomatic manual-feed paper handling (single sheets, envelopes, and transparencies) and an optional automatic 70-sheet feeder (£35).

The SpeedJet 200 comes with a 128-KB memory and is compatible with the HP DeskJet+ (PCL3+). Emulation cartridges for the IBM Proprinter 4207/Epson LQ-850, as well as 128- and 256-KB memory extensions, are available. Three font styles are available—Courier, Letter Gothic, and Times Nordic—and character versatility with italic, half-height, half-width, double-width, underline, boldface, superscript, and subscript. You can obtain optional font cartridges. The SpeedJet 200 has a footprint of 342 by 115 by 147 mm and weighs 2.9 kg.

Phone: +44 753 685873; fax +44 753 682036.

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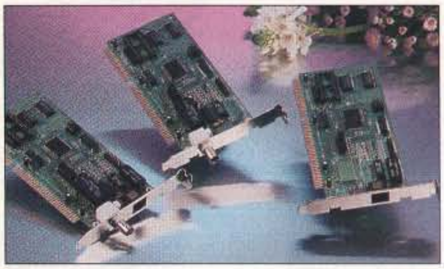
What's New International Hardware

JUMPER AND JUMPERLESS ETHERNET ADAPTER ▼



Genius LAN (Taipei Hsien, Taiwan) has added the GE2000II Jumper&Jumperless series to its range of Ethernet products. A plug-and-play solution, the package includes intelligent auto-setup software. However, for complete flexibility, the cards retain jumpers for engineers who prefer to use them. The GE2000II (call for prices) permits eight IRQ and eight I/O options, and it comes with drivers, including ODI, IPX for Novell NetWare, NDIS for Microsoft LAN Manager and Windows for Workgroups, and a packet driver for TCP/IP. The card is compatible with Novell NE2000. Features include an auto-detect media type, auto-detect for 8- or 16-bit bus interfaces, a transmission rate of 10 Mbps, and an optional 8-KB remote-boot ROM.

Phone: +886 2 995 6645; fax +886 2 995 0704.

Circle 1429 on Inquiry Card.

AN EXPANDABLE NOTEBOOK PC

CIC Computers (Southall, U.K.) says that its Cardstar is the only notebook PC that can take half-length and two-third-length PC expansion cards within the body of the notebook and still run on battery power. Based on the Intel 486 family, from the 25-MHz 486SX to the 50-MHz 486DX2, the Cardstar (from £1349) offers mono LCD, passive-color LCD, and active-color TFT screen options.

Standard features include 4 MB of RAM (expandable to 8 or 12 MB using standard IC memory cards) and a 130-MB hard drive (expandable to 180 or 265 MB); a PCMCIA slot that can take Type I and II devices; serial, parallel, external monitor, expansion box, and optional fax and modem ports; a PS/2 mouse and external keyboard port; multimedia capabilities; and a 16-bit ISA internal expansion slot. Dimensions are 290 by 220 by 49 mm, and the Cardstar weighs 2.8 kg.

The 2½-inch 130-MB hard drive is removable within its own casing. Areal designed the drive especially for robustness and light weight. In addition, the 3½-inch floppy drive is removable, and you can add a battery in its place, extending the notebook's usability on the move. The pointing ball of the built-in trackball is placed in the top right corner of the PC, with the left and right buttons at the top left. This lets you use the trackball with both hands in a natural resting position on either side of the notebook.

Phone: +44 81 813 8217; fax +44 81 574 6939.

Circle 1428 on Inquiry Card.

HIGH-SPEED NETWORK PRINTING

Designed as a central network printing resource, the T9017 is a 16-ppm laser printer capable of producing 50,000 pages per month. The printer from Mannesmann Tally (Wokingham, U.K.) comes with paper-handling options and networking alternatives, which means that you can use it in a variety of leading network environments.

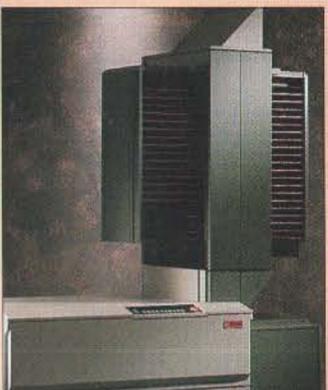
The T9017 features dual input cassettes of 250-sheet capacity each as standard, so different paper types can be handled simultaneously, and 350-sheet output capability. An optional multipurpose feeder for items such as envelopes is available, as are a mailbox sorter and duplex unit for double-sided printing, a 1500-sheet feeder, and a 1500-sheet large-capacity stacker.

The T9017 (£2699) features LaserJet IIISi and Proprinter XL24 emulations, and it has 13 scalable fonts and 14 resident bitmap fonts as standard. Adding the extra memory and the Mannesmann Tally PDL module makes the printer PostScript-compatible. Automatic emulation sensing is provided for multiapplication environments.

Phone: +44 734 788711; fax +44 734 791491.

Circle 1448 on Inquiry Card.

NETWORK LASER PRINTERS



Two PostScript-compatible laser printers from Océ Printing Systems, the Océ 6730 and Océ 6845, are designed for mid- to high-volume applications. Both print engines are powered by a controller that is equipped with 32 MB of RAM and incorporates Crown Architecture technology for multitasking processing. The Océ 6730 (£35,000) can print at 30 ppm and is the ideal solution for volumes of up to 150,000 copies per month. The Océ 6845 (£50,000) can print at speeds of up to 45 ppm at a resolution of 300 dpi, and it can handle print volumes from 40,000 to 400,000 copies per month.

An internal 200-MB hard drive stores multipage jobs and large image-intensive files. The SCSI port provides the option to connect up to six external hard drives of any capacity.

The printers offer double-sided printing at their full engine speed, and they are able to automatically collate output with pages separated into 20- or 40-bin intelligent stacker/sorters (2000- and 4000-sheet capacity, respectively) or a dual-tray stacker/stapler (1700- and 500-sheet maximum capacity, respectively).

Standard interfaces on the Océ 6730 and Océ 6845 are serial, parallel, and Apple LocalTalk. There are two additional interface slots for adding any combination of interfaces via Ethernet (i.e., NetWare, TCP/IP, EtherTalk, or DECnet) or Token Ring (i.e., NetWare or TCP/IP) topologies, both of which are built in. Languages supported include PostScript Type 1 and 2, Hewlett-Packard PCL 5, DEC LN03+, and, for high-quality communications, CCITT Group 4.

Contact: Océ Printing Systems, Loughton, U.K., +44 81 508 5544; fax +44 81 532 0845.

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Luckily, there are some less painful ways to leave a lasting impression. Simply have a close look at the Minolta range of laser printers. They're built to set new standards with the combination of two unique Minolta technologies. First, there is the original Fine-ART (Advanced Resolution Technology) that produces smoother curves and eliminates the "jaggies". Second there is Minolta's Fine Micro-Toning System to guarantee crisp, clear print from first to last. And thanks to the remarkable RISC Controller, our laser printers process data, even the most complicated graphics, faster than any other printers in their class. No wonder Minolta claims to put you first.

MINOLTA

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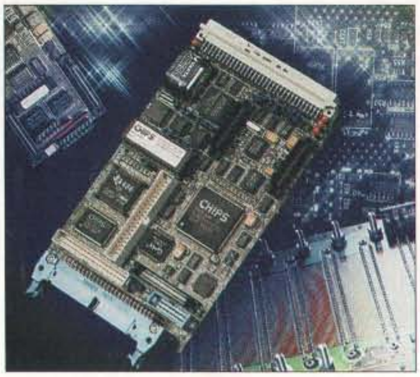
Circle 520 on Inquiry Card

What's New International Hardware

AT-COMPATIBLE STEBUS BOARD



Called SCIM-X (from £815), Arcom Control Systems' (Cambridge, U.K.) latest integrated STEbus PC-compatible board provides a single-board solution for demanding embedded DOS and Windows applications. The board packs a Cyrix 486SLC CPU with more than 100 MB of RAM and flash EPROM onto a compact 100- by 160-mm single Eurocard. Integrating the hardware of up to three existing STEbus modules, you can use the SCIM-X for real-time and embedded industrial control and instrumentation applications.

The memory array offers IC sites for populations of up to 8 MB of zero-wait-state dynamic RAM, 128 KB of battery-backed static RAM, and 2 MB of flash EPROM. You can extend it by a further 16 MB of RAM using the mezzanine bus-expansion facility. Other on-board hardware includes a site for a math coprocessor, IDE and floppy drive controllers, a keyboard interface, a real-time clock and watchdog timer, loudspeaker output, and COM1, COM2, and LPT1 ports. A serial-organized 256-byte EEPROM provides fail-safe retention of BIOS configuration data and other information, like hardware/software version and issue.

Three expansion routes provide configuration flexibility. The main STEbus interface—implemented via the two-part DIN41612 connector—includes full multimaster arbitration, allowing the construction of very high performance systems with parallel processing. A local expansion interface via the open-architecture SCIM mezzanine bus provides a means of closely matching the on-board hardware to industrial requirements to minimize system board count and costs.

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Circle 1438 on Inquiry Card.

NETWORK CONNECTIVITY FOR TOSHIBA PCS

With the IME (Saarbrücken, Germany) Ethernet Internal (995 deutsche marks), you can connect your Toshiba computer to Ethernet networks through its dedicated modem slot instead of by means of parallel network adapters. The card has 140-KBps maximum data throughput and power-conservation features. The installation of the card is as easy as adapting a modem for the dedicated modem slot, according to the company.

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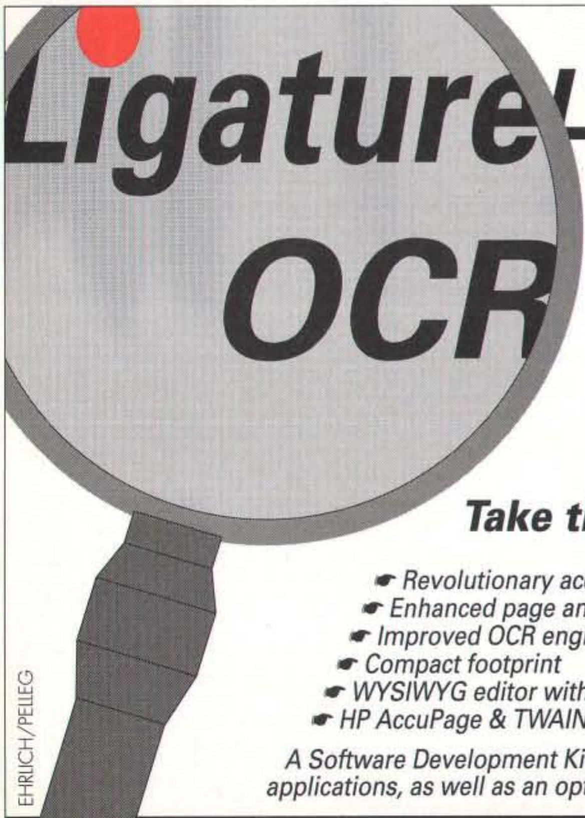

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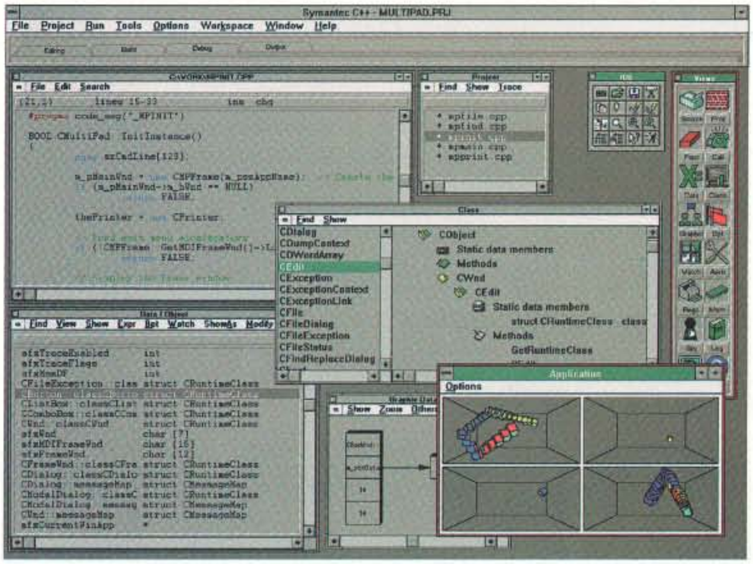

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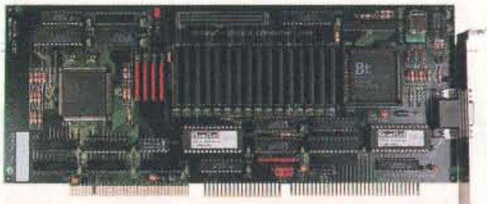
What's New International Hardware



GRAPHICS CONTROLLER

A high-performance graphics controller based on the S3 86C928 chip set, the Datapath (Derby, U.K.) Orion is ideal for demanding multiscreen applications where you can plug three Orion cards working together into the same machine. The Orion is VGA-compatible, offering VESA enhanced and extended modes at a resolution of up to 1600 by 1200 pixels with 256 colors, Pseudo True Color (65,536 colors) at a resolution of up to 1280 by 1024 pixels, and True Color at a resolution of up to 1024 by 768 pixels. All displays are noninterlaced, with ergonomic refresh.

Three versions are available: the Orion-3Star, Orion-Win/TC, and Orion-5Star. The Orion-3Star (£499) has 2 MB of VRAM to support modes of up to 1024 by 768 pixels with 65,536 colors and 1280 by 1024 pixels with 16 colors, with double buffering at high refresh. The Orion-Win/TC has 4 MB of VRAM for resolutions of up to 1024 by 768 pixels True Color, making it ideal for Windows applications. The Orion-5Star range has 4 MB of VRAM, for resolutions including 1024 by 768 pixels True Color, up to 1280 by 1024 pixels with 65,536 colors, and 1600 by 1200 pixels with 256 colors.

Phone: +44 332 294441; fax +44 332 290667.

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HIGH-RESOLUTION PRINTER CARD

You can now print ultrasonic, x-ray, industrial, and microscope images on your Hewlett-Packard LaserJet 4 with LazarPrint from Klughammer (Markt Indersdorf, Germany). A card for printing black-and-white images, LazarPrint (3850 deutsche marks) lets a LaserJet 4 print photographic quality in resolutions of 2400, 3600, 4800, or 6800 dpi. The card can combine images, especially TIFF images, with text or graphics and print them under applications such as Windows, Ventura Publisher, Aldus PageMaker, and QuarkXPress.

You can combine text and graphics for use in medical applications; analysis (e.g., electrophoresis and chromosome analysis); electron microscopy (e.g., chemistry, biology, and police); and industrial applications.

LazarPrint features 256 gray scales out of a possible 1024; a loadable lookup table for every page; combining of text, graphics, and images without programming; operation of the laser printer with minimum memory capacity; driver software; software-controlled functions; the optional compression and decompression of TIFF data; and Windows DLL is available.

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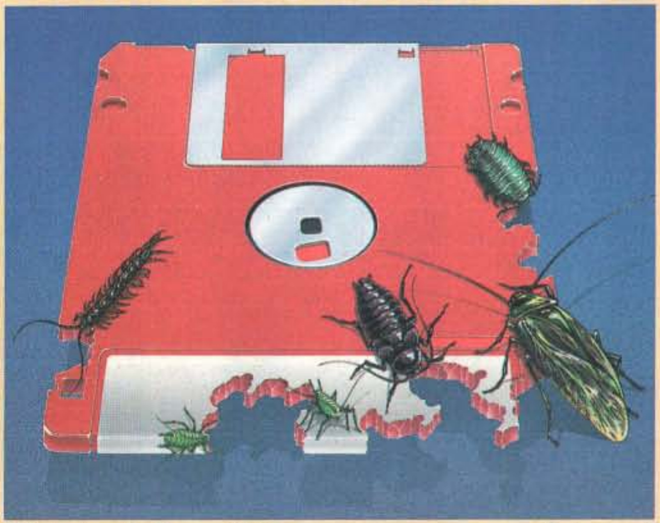

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THE SECURITY KNOW-HOW

PARASITE: "...an organism that lives off others, causing them harm".

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- **EP** : with programmable codes, memory and capability to detect any attempts to break in
- **NET**: for local network applications
- **SR** : for software protection on workstations, mini and mainframes (on serial ports)

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MINUTEMAN will repair or replace equipment, up to $25,000 in value, damaged by AC surges while properly connected to this MINUTEMAN UPS. See warranty inside.

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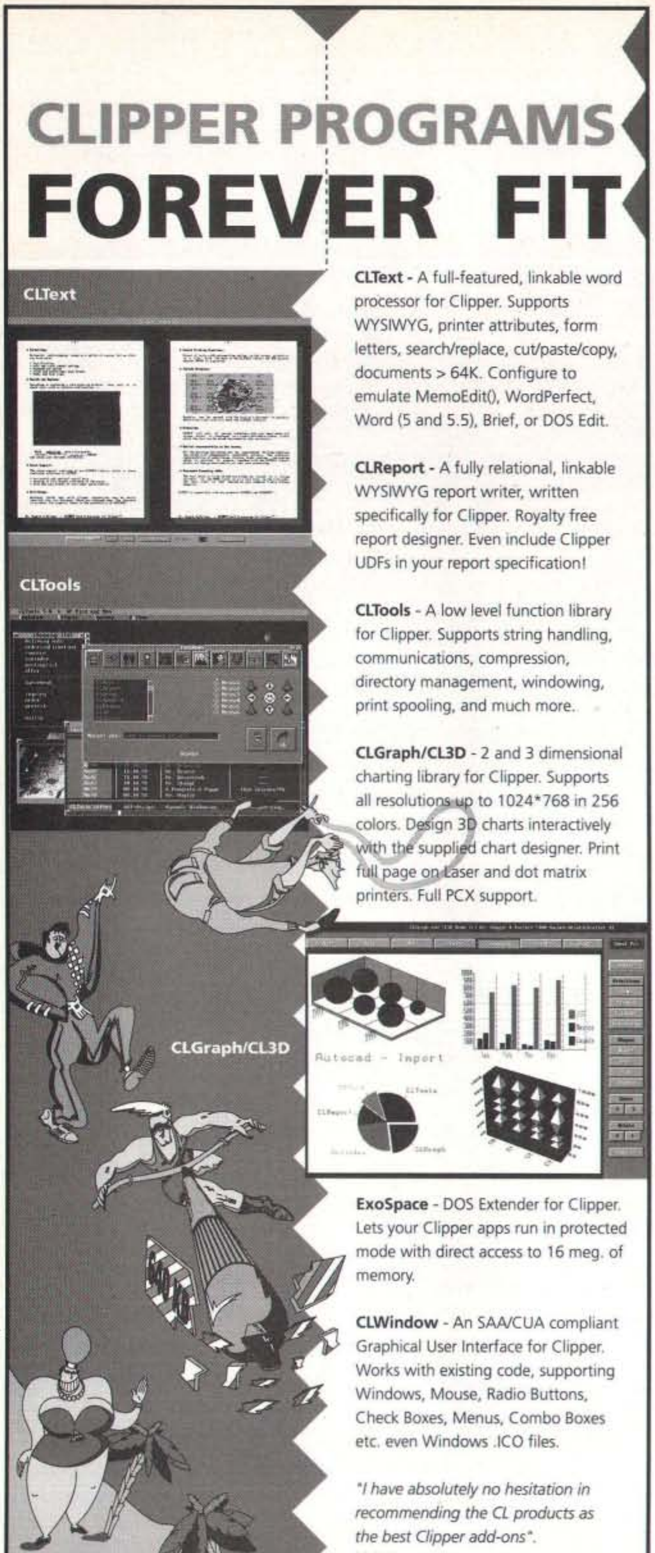

CLIPPER PROGRAMS FOREVER FIT

CLText - A full-featured, linkable word processor for Clipper. Supports WYSIWYG, printer attributes, form letters, search/replace, cut/paste/copy, documents > 64K. Configure to emulate MemoEdit(), WordPerfect, Word (5 and 5.5), Brief, or DOS Edit.

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CLTools - A low level function library for Clipper. Supports string handling, communications, compression, directory management, windowing, print spooling, and much more.

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Circle 510 on Inquiry Card (RESELLERS: 511).

What's New

COLOR DOT-MATRIX PRINTER

A 24-pin dot-matrix printer, the SL-96 Colour uses the ESC/P2 optimized printer language, which lets the machine print scalable fonts with variable heights and extremely precise graphics output, according to Seikosha (Slough, U.K.). The 24-pin technology has a resolution of 360 by 360 dpi, which ensures maximum quality whether the SL-96 Colour is printing text or graphics. It is further enhanced by its ability to achieve a maximum speed of 240 cps (84 cps in letter-quality mode).

The SL-96 Colour (£249) provides eight bit-map fonts and two scalable fonts (8 to 32 points). The printer can handle single sheets and fanfold paper, and, combined with a convenient auto-park feeder, the built-in push tractor ensures easy switching between these two types of paper. The paper tray facilitates fully automatic single-sheet feeding; an optional sheet feeder is available (£82).

The SL-96 Colour has a capacity of 42 KB of memory. You can connect the SL-96 Colour to any PC via its Centronics port. The Epson LQ-870 emulation ensures that the printer is compatible with popular programs, and the printer comes with a Windows driver; a driver for Amiga is available on request. The SL-96 Colour measures 417 by 140 by 360 mm and weighs 4.3 kg.

Phone: +44 753 685873; fax +44 753 682036.

Circle 1440 on Inquiry Card.

HARDWARE ANTIVIRUS AND SECURITY SYSTEM

ViruGuard is a hardware-based virus neutralization and PC security device designed to recognize virus actions rather than ever-changing virus morphologies, so it can provide proactive protection against known and unknown viruses. As a result, ViruGuard does not require upgrades. Available from NMB Marketing (London, U.K.), ViruGuard functions as an intrinsic part of the PC and loads directly after the PC BIOS. In addition to antivirus protection, the package offers eight user-access controls, data security, productivity management, and protection against software piracy in the form of an add-on card that, once you install and initialize, never needs upgrading.

ViruGuard (£125) protects the primary and secondary boot sectors, partition table, FAT, root directory files, hard drive data area, executable files, critical files, read-only attributes, and file and memory control blocks. Other features include individual user password and identification; individual access control using virtual drives, TSR, and IVT monitoring; disallowal of low-level formats; directory and file locking; hard drive locking on removal; screen blanking; productivity analysis by user, PC, department, or site; and drive data encryption. Special KILL features disable viruses in memory, allowing safe execution of infected programs.

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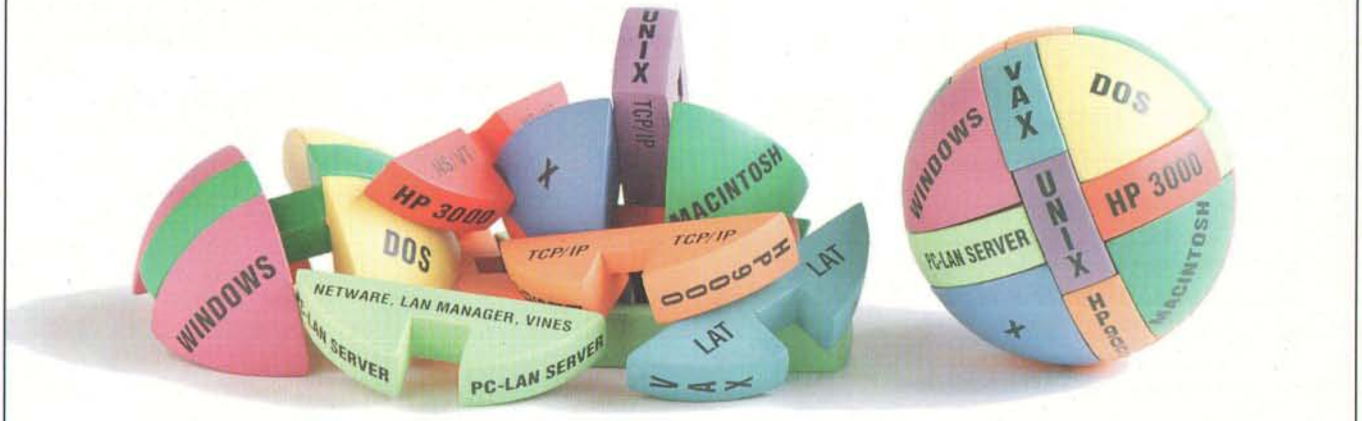
PC connectivity?



Reflection makes it child's play.

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What's New

INDUSTRIAL PCS ▲

The Ay-PCs from Aydin Controls (Hitchin, U.K.) are a family of industrial PCs designed for harsh environments (e.g., the factory floor and production areas). The Ay-PCs are ruggedly constructed to withstand shock and high vibration levels. Systems in the range include passive 10-slot backplanes with plug-in Intel 386- and 486-based processor boards, rugged and sealed keyboards, and various complementary color monitors.

For fail-safe operation, an internal battery runs a UPS, which automatically takes over in the event of a main power failure. The Ay-PC is built to meet the latest European EMC/EMI radiation and interference immunity specifications. Desktop, 19-inch rack mount, and deskside enclosure versions are available, all manufactured from heavy-duty nickel-copper-plated steel. For mobile and field use, the Ay-PC can operate from a 24- or 48-VDC power supply.

For security-conscious applications, the Ay-PC (from £2500) comes with high security locks to the disk drives and a power switch to prevent unauthorized access and use.

Phone: +44 462 458804; fax +44 462 456761.

Circle 1441 on Inquiry Card.

DIGITIZING TABLET FOR WINDOWS AND THE MAC

A new type of digitizing tablet for Windows and the Mac, the UD-1212 from Computers Unlimited (London, U.K.) is an A4 tablet designed for computer graphics experts and CAD specialists. The tablet has an active area of 12 by 12 inches, providing an A4 tablet in landscape and portrait orientations.

Weighing only 8 g, the UltraPen stylus is light and thin and as natural to use as a conventional ballpoint pen. The pressure-sensitive pen supports 120 application pressure stages. In addition to the cordless stylus, a four-button magnifying puck is supplied standard with the UD-1212. To further increase functionality, you can use the two input devices simultaneously, so you can rapidly handle objects, easily and intuitively, particularly for CAD work.

An additional menu strip of 12 soft function buttons and macro application support lets you assign commonly used keyboard commands or macros to each button for each application, activated by a simple touch of the pen. The UD-1212 (£699) is equipped with advanced drivers for Mac, Windows, DOS, and OS/2. The software includes an intuitive Control Panel for customizing pressure response curve options, tablet-to-screen scaling, and button configuration.

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1991 BYTE AWARD OF DISTINCTION

COMPUTER LANGUAGE PRODUCTIVITY AWARD 1990

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286|DOS-Extender is one of the most widely used 16-bit DOS extenders available. If you'd like to know why, take a look at what our customers and other industry experts have to say about the 286|DOS-Extender SDK. Then find out for yourself by trying the free 286|DOS-Extender Lite — or get started right away on your multi-megabyte DOS applications with the professional 286|DOS-Extender SDK!

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"A no-compromise solution for Borland C++ developers"
- Paul Gross, Borland International

"An excellent product technically"
- Glenn Axworthy, Brøderbund Software

"Gives our customers the memory they need"
- Bert Love, Galacticomm, Inc.

"A superb way of utilizing all available memory"
- Dave Jewell, Program NOW, August 1991

New virtual memory support.

NEW VERSION 3.0

In addition to Visual C++ support, 286|DOS-Extender, Version 3.0 now includes Phar Lap's 286|VMM virtual memory manager. 286|VMM is completely integrated into 286|DOS-Extender (you invoke 286|VMM with a command-line switch) and enables you to transparently access more memory than is physically available in your computer. 286|VMM can improve the performance of applications that previously relied on loading and unloading dynamic link libraries (DLLs). And it's fully DPMI-compatible, so programs running under Windows automatically use the virtual memory provided by Windows.

NEW! TNT DOS-Extender- Get NT Power under 32-bit DOS!

If you want 32-bit speed and performance, as well as powerful new NT features for your DOS applications, Phar Lap's TNT DOS-Extender is the answer. With TNT, you can use your familiar Microsoft Visual C++ 32-bit Edition compiler to write programs that run in a workstation-like, unsegmented 32-bit address space while implementing threads, DLLs and multitasking. It's never been so easy to create the most powerful, full-featured DOS programs ever.

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Phar Lap Software, Inc.

60 Aberdeen Avenue, Cambridge, MA 02138 617-661-1510 FAX 617-876-2972

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Circle 525 on Inquiry Card.

What's New International Hardware

BRIGHTEN UP YOUR WORKSTATION

Designed by medical professionals, the Inpace (Witney, U.K.) wrist rests, mouse pads, and mouse covers help to minimize strain on your body while you are working at a keyboard. Developed for improved comfort and handling, the Padware products can help to reduce user fatigue and improve productivity.

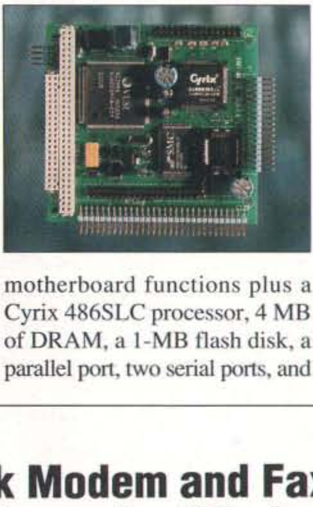
All three products are available in raspberry red, royal blue, and jade green and are machine washable. The wrist rest (£12.95) has a slope and rounded edges. Contoured to the natural movement of your wrist, it helps reduce repetitive strain injury and carpal tunnel syndrome. The circular mouse pad (£7.95) minimizes desk footprint and provides an optimal work area. Soft edges eliminate wrist irritation from hard corners. The mouse cover (£9.95) slips over the mouse, has a soft touch, and maintains constant metacarpal elevation. It is available for Apple and Microsoft mice.

Phone: +44 993 706303; fax +44 993 706305.

Circle 1444 on Inquiry Card.

EMBEDDED 486 ON STACKABLE CARD

Advanced Micro Peripherals (Little Ouse, U.K.) has added the Tiny486 to its range of PC-compatible embedded computers. The board integrates standard PC motherboard functions plus a Cyrix 486SLC processor, 4 MB of DRAM, a 1-MB flash disk, a parallel port, two serial ports, and a disk interface for direct attachment of floppy and IDE drives. On-board PS/2 keyboard and mouse ports complete this low-cost embedded AT. The PC/104 bus lets you stack low-cost expansion cards one on the other, or you can plug them into a user-application-specific board. The Tiny486 (£495) runs DOS and user applications from disk or entirely from the on-board flash disk.



Phone: +44 353 76311; fax +44 353 667005.

Circle 1450 on Inquiry Card.

UPGRADE YOUR 286 PC

Make-it 386 and Make-it 486 from Workstation Source (Lower Earley, U.K.) are direct replacements for the 286. You simply remove the 286 chip using the provided tool and fit the new module in its place. There are no jumpers to change, no DIP switches to set, no BIOS changes, and no software drivers to load. Make-it's miniature size fits most computers, including laptops and notebooks. After upgrading, the system is recognized by the latest software as a 386 or 486, including Windows enhanced mode, Windows NT, OS/2, NetWare 386, and AutoCAD 386.

Make-it 386 (£125) is a low-cost way to get full 386 compatibility on a 286 system. There is also a version that doubles the clock speed (£150). For the best performance, Make-it 486 (£275) has a built-in clock doubler and can give speed increases from 200 percent to more than 400 percent. Make-it 486 is available with a math coprocessor (£360).

Workstation Source also offers Extend-it 16, a low-cost method of adding memory to your system up to three times faster than conventional 8-bit boards. It provides four standard SIMM sockets, for up to 16 MB of extended memory. Extend-it 16 also provides a back-fill capability for conventional memory from 512 KB to 640 KB for systems without full memory (unpopulated, £130; with 4 MB, £350).

Phone: +44 734 759292; fax +44 734 757522.

Circle 1445 on Inquiry Card.

WINport **Network Modem and Fax Sharing Software for Windows & DOS**

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☑ **DOS:** WINport also includes an INT-14h driver for DOS software such as pcAnywhere, CIM, Rencom, etc...

☑ **User Friendly:** WINport can be completely transparent to users. They won't even know they're using a shared modem!

☑ **FAXport:** WINport includes FAXport, a fax server module, for store and forward faxing, network fax queuing, and inbound fax forwarding & routing.

☑ **Value Added Differences:** Access Security, Modem Traffic Management, Diagnostics, Queueing, Fax Notification, Support of ISDN Controllers With True COM Port Emulation

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LANSource UK Tel: 44 223 237778, Fax: 44 223 237758

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What's New International Software

TURN FAXED FORMS INTO DATA

TeleForm from Ctc automatically reads hand-printed, typed, or tick-box information from faxes or scanned forms and converts it into computer data. The forms, which you create using the TeleForm designer, can contain any combination of alphanumeric, numeric, tick-box, and image-capture fields for either hand-printed or typed information. You can link forms across multiple pages and incorporate company logos, graphics, and informational text.

When forms are faxed into the TeleForm system, they are automatically read by the software. The data is extracted and directly exported to a host system or passed to the TeleForm manual validation and correction module. TeleForm supports ASCII, Paradox, dBase, Oracle, SQL, and IBM DB2 host data formats. Teleform (£1495) runs under Windows, with a NetWare concurrent-multiprocessing option available for high-volume applications.

Contact: CtC Ltd., Deepcut, U.K., phone and fax +44 252 835315.

Circle 1451 on Inquiry Card.

HEALTHY COMPUTING

Available in German and English, PC-Fit provides information and enhances health awareness and motivation while you work at your computer. You can use the software from HumanWare (Burggasse, Austria) in three ways: as an alarm clock to remind you to take breaks, as a series of exercises for the body and eyes, or as tips on workstation design.

After a user-defined period, the alarm-clock option interrupts your current task and offers a break, which you can accept, defer, or cancel. PC-Fit (DOS version, 1970 schillings; DOS network version, 1680 schillings; DOS/Windows version, 2390 schillings; DOS/Windows network version, 2110 schillings; Mac version, 2390 schillings) lets you set breaks individually at each workstation, and the message does not disrupt your work in progress.

The exercises for the body and eyes are designed to counter stresses typically experienced by computer workers. PC-Fit describes and demonstrates every exercise on-screen, and you can easily perform them at your workstation. The tips on workstation design contain expert information on the main aspects to keep in mind (e.g., correct distance from the monitor and how to use breaks properly) and the ways in which you can improve the situation.

Phone: +43 222 52602880;
fax +43 222 52602889.

Circle 1455 on Inquiry Card.

HINDI-ENGLISH CD-ROM DICTIONARY

Elektroson (Eindhoven, The Netherlands) offers a Hindi (in Devanagari)/English dictionary on CD-ROM that runs under Windows. Within seconds, you can obtain word meanings and associated phrases. The CD-ROM (950 Dutch guilders) lists words ranging from current to archaic to accommodate readers of both contemporary texts and older literature.

A number of Hindi idioms, sayings, and proverbs are included, along with everyday expressions from various dialects, technical terms for most fields of knowledge, and characteristic mythological names with their related idioms and phrases. The Hindi/English dictionary on CD-ROM contains 65,000 entries and, to facilitate looking up entries, a four-way search method. Hypertext-like structure is built in, letting you browse through the text and click on any of the highlighted words, so you can choose your next selection without having to return to the main menu.

Phone: +31 40 515065;
fax +31 40 514920.

Circle 1456 on Inquiry Card.

LISP-TO-C

If you're a Lisp programmer in the process of moving your applications to C, Lisp2C may prove to be of interest to you. This program translates AutoLisp source files into C source files that you can further compile using a Watcom or MetaWare C compiler. In addition to C source code (documented with Lisp statements), Lisp2C provides the batch, linker, and make files you need to build an executable file and a garbage collector that finds and releases all the memory for you.

A built-in debugger lets you execute a program step-by-step, tracing into the functions or stepping over them, monitoring and resetting variables on the fly, defining new functions, and loading the parts of the code. Lisp2C (US$1000) speeds up your applications and makes the development of ADS applications easier, according to Basic (Ljubljana, Slovenia). You can prototype an application using your AutoLisp interpreter and later compile it to an ADS application.

Phone: +386 1 314069;
fax +386 1 318211.

Circle 1457 on Inquiry Card.

ELECTRONIC DESIGN

A CAD/CAE/CAM system for electronic design on the Mac, Run EDS 2.2 integrates schematic capture and PCB layout with Real-Annotation. Version 2.2 (28,500 deutsche marks) extends the connection of copper areas to electrical networks. Online checks show newly calculated copper areas during the modification of parts, contacts, or copper traces. You will not need further postprocessing. Run EDS 2.2 immediately calculates and displays the real copper. The program also recalculates deleting, turning, or replacing part packages within a copper area and updates the graphical display to show the true copper after each modification.

Run EDS 2.2 lets you interactively work on a fully coppered routing layer and check your design rules immediately. If a copper area is generated over a layout or a partial layout, the software from Formula (Nürnberg, Germany) generates thermal connections to contacts of the same electrical network. If the size of the isolated copper area is below a user-defined minimum, Run EDS can locate isolated copper areas and remove them. The program then connects the remaining isolated copper areas to the next available copper. The multiple Undo/Redo steps let you correct all operations with a simple keystroke.

Phone: +49 911 286600;
fax +49 911 286221.

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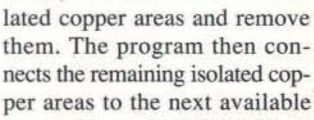
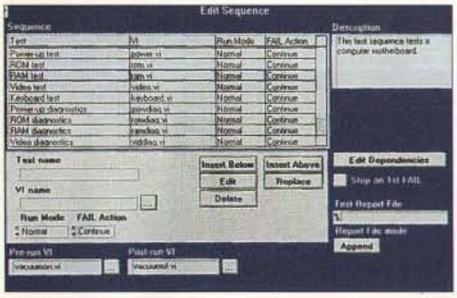


What's New International Software



Sequence

Test	VI	Run Mode	FAIL Action
Power-up test	power.vi	Normal	Continue
ROM test	rom.vi	Normal	Continue
RAM test	ram.vi	Normal	Continue
Video test	video.vi	Normal	Continue
Keyboard test	keyboard.vi	Normal	Continue
Power-up diagnostics	powdiag.vi	Normal	Continue
ROM diagnostics	romdiag.vi	Normal	Continue
RAM diagnostics	ramdiag.vi	Normal	Continue
Video diagnostics	viddiag.vi	Normal	Continue

Description: This test sequence tests a computer motherboard.

Test name

VI name

Run Mode: Normal

FAIL Action: Continue

Test Report File

Report File mode: Append

Pre-run VI: vacuumon.vi

Post-run VI: vacuumof.vi

AUTOMATED TEST PROGRAM ▲ SEQUENCING

With National Instruments' (Newbury, U.K.) LabView Test Executive Toolkit, you can run automated sequencing of test programs in LabView. The Toolkit comes with a Test Executive, which can incorporate a suite of test virtual instruments, along with a Sequence Editor for developing test sequences with dependencies. The LabView Test Executive Toolkit (£442) delivers the Test Executive and Sequence Editor in block-diagram source code with high-level modules, making it easy to modify them to meet different needs.

The Test Executive VI runs test sequences you have created and saved, prompting you for information, displaying the list of tests and current results of each, and posting pass/fail banners. After execution, you can view the logged results and generate an ASCII file that includes the name and description of the sequence, the date and time that testing was completed, the operator name, and the results of each unit's tests. By invoking the Sequence Editor VI, you set the specifications for sequences like test dependencies, stop on error, and loop on error. You also use the Sequence Editor for debugging by setting force pass, force fail, or skip on given tests.

Phone: +44 635 523545;
fax +44 635 523154.

Circle 1463 on Inquiry Card.

ANALYZE ACOUSTICS AND VIBRATION

Rayon analyzes the fluid/structure interaction and vibroacoustic behavior of complex structures vibrating in one or more surrounding fluids. From Straco (Compiegne Cedex, France), Rayon simplifies modeling by avoiding volume meshing and reducing the number of unknowns, particularly where fluids occupy spaces that are extended or without limits.

Input to Rayon consists of a geometric model with a mesh that is defined by boundary finite elements. To define boundary conditions, Rayon uses the prescribed acceleration and pressure, acoustic treatment, and elasticity. It defines acoustic source fields in the surrounding fluids (as plane incident waves, a pinpoint source, or a diffused field) or on the boundaries (as acceleration of resonant elements or pressure of source elements). Rayon represents mechanical sources as pinpoint forces or distributed along loaded elastic sections. Analysis results are presented as acoustic pressure and intensity at the boundary and in the field, as well as acoustic velocity in the field. Rayon also provides mechanical acceleration at the boundary and in the elastic field.

Two versions are available: Rayon-3D and Rayon-AXI (350,000 French francs each). Rayon-3D handles general 3-D structures with a boundary element library consisting of three- and six-node triangles and four- and eight-node quadrangles. Rayon-AXI models axisymmetric structures with two-node linear elements and three-node quadratic elements.

Phone: +33 44 865900;
fax +33 44 868777.

Circle 1459 on Inquiry Card.

ECONOMIC INFORMATION ON CD-ROM

The Helsinki School of Economics Library (Helsinki, Finland) offers a CD-ROM for the PC that combines the indexes of five major European databases: Econis, Fonds Quetelet, IMA-NCOM, SCANP, and SCIMP.

Econis is a German database containing 343,000 references to articles, books, and journals from 1980 to the present on economic subjects from all over the world. A Belgian database, Fonds Quetelet, includes 124,000 references from 1980 to date. With an emphasis on Europe, main subject groups are economics, finance, statistics, labor, and enterprises.

IMA-NCOM contains 22,000 references to Nordic and international literature on communication and business, with abstracts from 1980 to the present. SCANP is a Scandinavian database that includes 33,000 references from 1980 to date on subjects such as business sciences and economics. SCIMP is a West European management database that includes 97,000 references to articles on management, personnel, finance, industry, and marketing in European and North American periodicals from 1980 to date.

The CD-ROM (yearly subscription with updates every six months, US$2200) includes Dataware's search-and-retrieval software. You can select the user interface in English, French, or Swedish.

Phone: +358 0 4313413;
fax +358 0 4313539.

Circle 1460 on Inquiry Card.

UTILITIES FOR THE MAC

Connectix Desktop Utilities from Computers Unlimited combines 16 utilities for greater control and customization of the Mac. The integrated program incorporates modules for energy conservation, screen saving, security, hot keys, keyboard shortcuts, file synchronization, and desktop customization.

The Power Manager utility focuses on cutting power consumption and supports the U.S. Environmental Protection Agency's Energy Star power-efficiency initiative. The utility decreases energy consumption by as much as 50 percent through a combination of techniques, including automatic shutdown and screen dimming.

Connectix Desktop Utilities (£79.95) provides a menu where you can instantly change your desktop settings, including sound level, monitor color depth, printer selection, and file-sharing status. You can select from a variety of color-coordinated schemes to customize the look of windows, menus, and controls. In addition, the package lets you select any picture to display on your desktop.

The package retains the popular features of the Connectix PowerBook Utilities, including file security, Balloon Help menu removal, and Mouseless Menus, which lets you select menus and buttons without using a mouse. Connectix Desktop Utilities also lets you use hot keys to open files or automatically type any text.

Contact: Computers Unlimited, London, U.K., +44 81 200 8282; fax +44 81 200 3788.

Circle 1452 on Inquiry Card.

GREY MATTER

Prigg Meadow, Ashburton, Devon TQ13 7DF

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C & C++ COMPILERS

NEW MICROSOFT VISUAL C++ 1.5 features a new version 2.5 of MFC and enhanced Wizards which add full support for OLE 2.0 and ODBC, with a set of royalty-free ODBC drivers. It is only available on CD-ROM and includes Books Online which provides fast access to over 5000 pages of documentation. Still no templates or exceptions - no, I don't know why not. ***ONLY £299.*** *UPGRADE FROM VC++ 1.0 PROF £72. Add £72 for printed compiler docs, £103 for printed SDK docs.*

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News & Views

The new Microsoft Visual C++ 1.5 is the first tool which simplifies the development of OLE 2.0 apps. If you have struggled with the OLE 2.0 SDK, order it now. If you have not got the OLE 2.0 SDK, its about time you found out about it, so you should order it as well. The new Wizards and MFC 2.5 support all OLE 2.0 functionality, including Visual Editing, OLE Automation, Optimised Object Storage, Component Object Model, etc. If this is double dutch to you, it shouldn't be. Chicago is less than 12 months away - don't get left behind. There's no excuse now. The other important bit is ODBC support - MFC 2.5 adds new database classes and a Record Field Exchange facility that manages the updating of data fields and controls. There is also a set of royalty-free ODBC drivers - these alone may be worth the asking price. Incidently, it is only available on CD-ROM - so rush out and buy a drive if you haven't got one.

ImageStream-VB will be of interest to Visual Basic/Visual C++/Borland C++ 4.0 developers who want to handle vector formats such as DXF. Call us for more info.

Finally, may we wish you all a Merry Visual Christmas and Prosperous OLE New Year.

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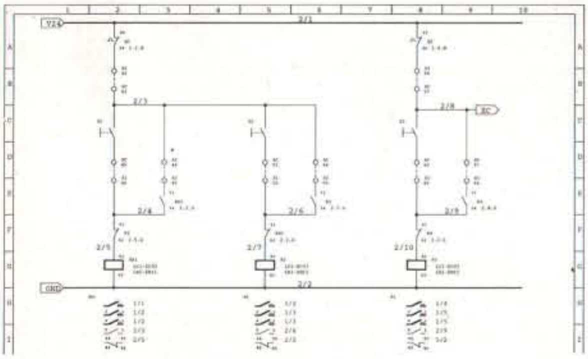

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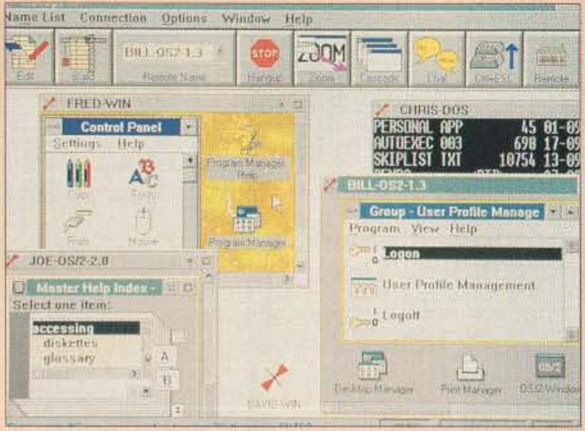

Richmond Systems has added the following to NetOpPM 4.21: full-speed remote-mouse support for DOS, Windows, and OS/2; support for OS/2 2.1 and Enhanced OS/2 mode; and support for the Microsoft Mouse 2. Version 4.21 (one control station and 50 remote PCs, £1265; 50 additional PCs, £875) lets you run remote control with no visible mouse delay. Now, all NetOp versions share the same TSR version, so that, for example, a network's remote PCs can connect to both NetOp for DOS/Windows and NetOpPM for OS/2 controller software.

Also available is NetOp 4.21 (one control station and 50 PCs, £695; 50 additional PCs, £200), which is DOS/Windows and OS/2 remote-control software. New features include full-speed remote-mouse support for DOS, Windows, and OS/2; compatible operating-system TSRs; and name tables that include fully automatic generation, alphabetical sorting of names, up to 500 names per table, an unlimited number of tables, search on first character, and deletion of all names in the table. Version 4.21 also includes support for DOS error levels, enhanced graphics support, a configurable NETOP.INI file, and enhanced peer-to-peer file transfer.

NetOp 4.21 facilitates integration with other systems, such as controlling the execution of NetOp from a menuing application. It has added support for Cirrus Logic graphics adapters, and 43- and 50-line text modes for OS/2 in EGA and VGA. Just as you can specify defaults and configuration information in the WIN.INI file for Windows, NetOp offers its own .INI file to configure everything from the default name table. NetCopy lets you transfer files between DOS and DOS, OS/2 and OS/2, and DOS and OS/2, including directories and directories with extensions.

Contact: Richmond Systems, Richmond, U.K. +44 81 940 6986; fax +44 81 948 2026.

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LOTUS ORGANIZER IN RUSSIAN

The Russian version of Lotus Organizer 1.0 (US$75) is available in the Commonwealth of Independent States and the surrounding Baltic countries from Lotus Development Russia (Moscow, Russia). The fully translated version of the PIM lets you track, prioritize, view, and update daily work. It uses a system that features a familiar notebook-style metaphor similar to the manual organizers most businesspeople use to manage their time and projects.

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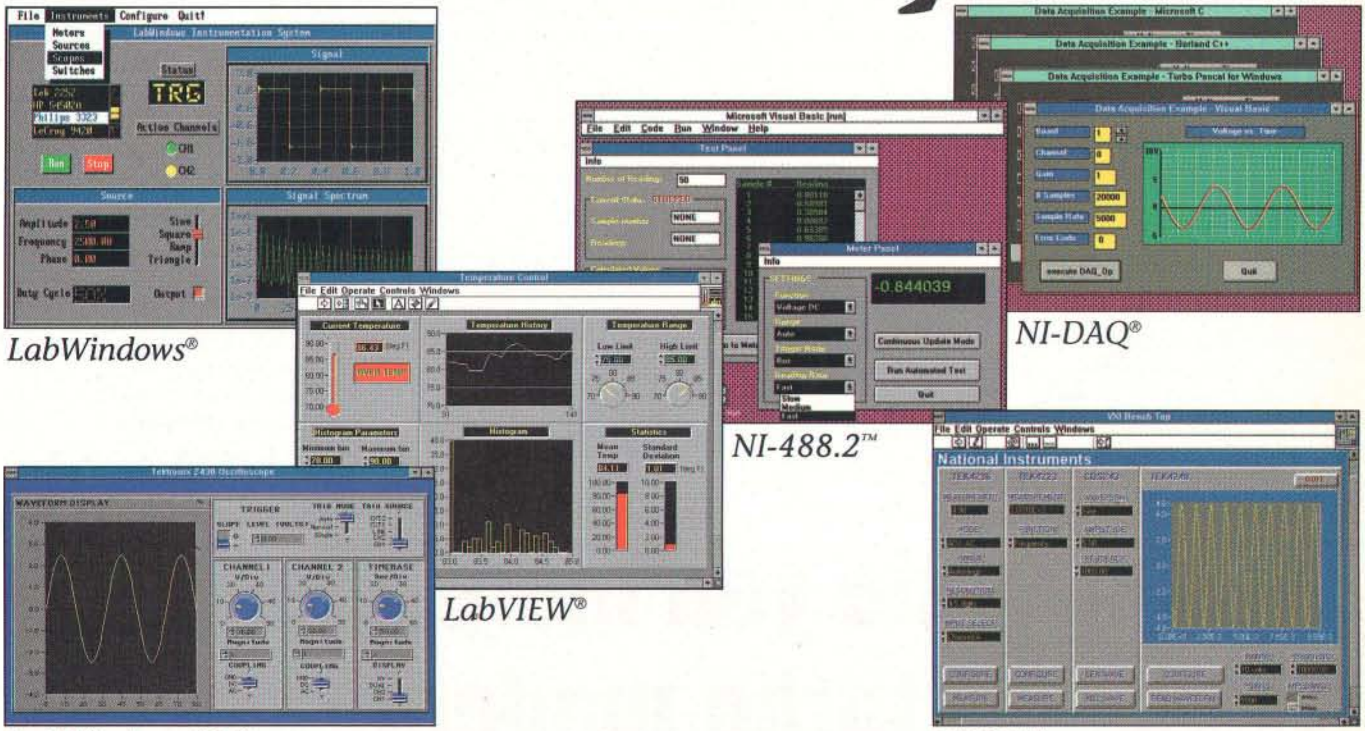

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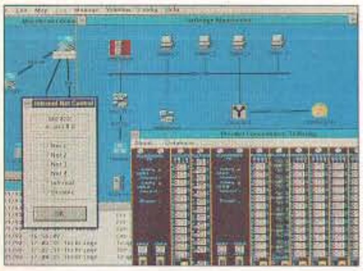
What's New International Software



SNMP NETWORK MANAGEMENT

If you run it on a PC under Windows, PlexView 2.04 from M. L. Electro-Optics (Chadderton, U.K.) will help you when managing a medium- to large-size network. The package (£2750) records parametric information on a per-node basis and generates reports in both graphical and tabular form, providing statistics on packets, bytes and packet size, and errors (e.g., CRC, alignment, jabber, runts, short preamble, and illegal interframe spacing).

PlexView helps you identify bottlenecks and traffic characteristics between nodes to assist in planning network enhancements and upgrades. You can print a hard copy of the network configuration for disaster recovery, future reviews, moves, and changes.

The View facility lets you quickly display a specific part of the network or find a particular node. The Auto-Discovery feature automatically identifies many suppliers' products and finds new nodes or unknown nodes and intruders. Full RMON support provides a standard interface to manage and obtain useful information from any RMON products.

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MULTIMEDIA AUTHORING SYSTEM

Pole Position Services (Horsted Keynes, U.K.) offers Paul Mace Software's Grasp packages. Three versions are available: Grasp 4.01, Multimedia Grasp, and Visual Grasp. The packages let you create animated presentations, point-of-sale product demonstrations, interactive tutorials, and engineering simulations. Grasp can display up to 32,765 colors (with Hicolor) and supports popular graphics display standards of up to 1024 by 768 pixels. The programs support image file formats (including PCX, GIF, BMP, and PICT) and video-capture boards, printers, scanners, CD-ROM drives, and other devices.

Grasp 4.01 (£295) is an animation package that includes a programming language. You can use it for presentations, demonstrations, computer-based training, and special effects in films. The top-of-the-range package, Multimedia Grasp (£995), has a toolbox of new and revised multimedia programs and utilities, including the Grasp engine; a paint program; file-conversion tools, featuring sound, picture, and animation support for importing modules from other programs; a font editor; and a code library to support C programs. Visual Grasp (£125), the entry-level package, provides easy access to sound, graphics, text, animation, and full-motion video.

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Fortune 100 financial institution urgently needs new Client/Server application with end-user Windows support and multiple RDBMS (Oracle, Sybase, Rdb) access in a single data view.

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No matter what your position on Client/Server, Magic is the right development tool for the job. Its post-4GL technology replaces the coding cycle with an automated, table-driven programming environment. Complex Client/Server applications are developed in weeks instead of months - reducing both your development costs and backlog. And Magic's unique incremental migration approach gives you the option of introducing Client/Server technology in a gradual, planned and controlled manner using exisiting MIS assets. SQL databases and Windows can be integrated whenever required to reach full end-user Client/Server functionality while economizing on your up-front equipment and training expenses. So if you're searching for a system that makes quick work out of Client/Server development, it's time you have Magic fill out an application.

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What's New International Software

CLOSE ENCOUNTERS OF THE WINDOWS KIND

If you have more than a sneaking suspicion that the earth plays host to alien life-forms, UFO may interest you. Available from Guildsoft (Stoke, U.K.), the Windows-based graphics package explores the phenomenon of UFOs and other mysterious occurrences. The disk version (£34.95) contains a database with over 500 sightings, pinpointed map coordinates, as well as photographic evidence. The CD-ROM version (£44.95) contains everything the disk version has, plus 1200 sightings with photographs, full-motion video, and audio. The descriptive accounts cover a time period of 3000 years, from 1000 B.C. to the present.

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MANUFACTURING MANAGEMENT SYSTEM

Managers of medium- to large-size manufacturing enterprises can track their business against key performance indicators in real time with a client/server extension to Andersen Consulting's (London, U.K.) Mac-Pac for the AS/400 manufacturing, distribution, and financial management software system. The Enterprise Monitor (per user, about £5000) lets you view charts and graphs showing purchase orders overdue, sales orders on hold, or customers without activity.

An Expert Configurator extension helps make-to-order manufacturing businesses speedily compose and confirm complex orders. Integrated with the Mac-Pac Job Costing module, Expert Configurator also lets you monitor the progress and profitability of an individual job as it moves through the manufacturing process.

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LOW-COST LAN-ANALYSIS TOOLS

M-Group (London, U.K.) offers three products for Ethernet LANs designed to identify and isolate LAN-related faults, to predict potential bottlenecks, and to provide an accurate guideline as to what your LAN has or is currently doing in terms of node utilization and performance.

A statistical gathering tool, Comtest NMS (£495) divides network statistics into Traffic and Performance. Comtest NMP (£495) is a protocol analyzer that captures and decodes network traffic in real time and breaks down the data according to its protocol. It includes advanced filtering and triggering, selective displays, XMS support, and multiprotocol support. Comtest NMS and NMP are expandable to Comtest NM.

Comtest NM (£995) incorporates all the functionality of Comtest NMS and NMP, and it adds extra modeling and managing tools for fault diagnostics and testing. Diagnose mode lets you test the existence and current status of each node on the network.

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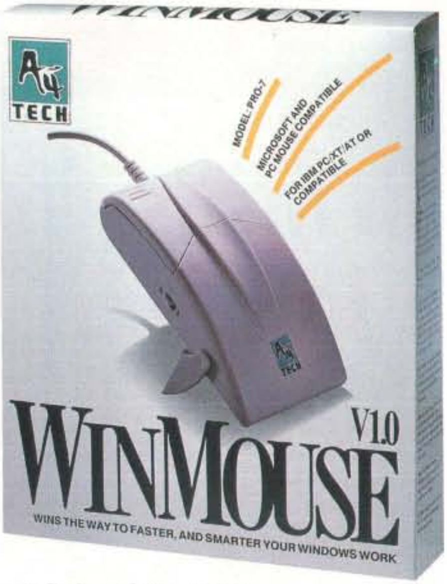
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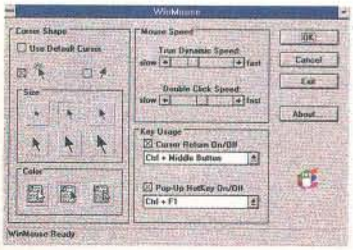

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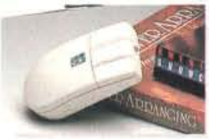

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Global Information Management By *Elex*

The Elex Global Information Management concept integrates into one system the management of structured and unstructured information, using the standard client database and application. Structured information is entered manually into the computer, whereas unstructured information, such as **Images, Forms, Voice and Video, Word Processing etc.,** is captured and manipulated by the relevant technology for each information object type.

Beyond simple electronic storage of paper

The difference between Global Information Mangement and the other technologies mentioned in the title of this article is more than just semantics, it is the difference between a system that simply transfers an existing paper filing system to an electronic media, adding some kind of searching mechanism, and a Global Information Management philosophy which offers an overall view in the management of the full mass of information which organizations handle on a daily basis.

The "Corporate Intelligence" of any organization consists of more than just paper. It includes voice, video, word processing, spreadsheets, etc. As a result, the challenge today is not to replace a paper archiving system with an electronic one. It is the challenge of supplying a comprehensive Information Systems solution for the comprehensive management of all the different types of information objects that the corporation deals with.

Advanced Technology

Elex works alongside most of the UNIX environment suppliers such as SUN (Strategic Partner), and suppliers of other environments such as IBM (OEM), and uses very sophisticated technologies in its Elex Electronic Filing system (EEF). These technologies include: **Client/Server** implementations, standard imaging technologies (**Scan, Store/Retrieve, Edit, Print, Communicate,** etc.), highly sophisticated **Neural Network** prediction systems developed by Elex to improve access time for a jukebox management system with more than **1 Terabyte storage,** and **Fractal compression** methods, also developed by Elex to deal with the problems in compression of large color images.

Most imaging projects in the last decade could not live up to the expectations, and often failed altogether. The main reason for such a poor result is that a user will not wait for more than 5 seconds to find a document in the system. Elex has therefore applied itself to resolving the performance problem by concentrating intensely on performance enhancement technologies such as **Form Separation** and applying **Neural Network prediction concepts** to jukebox storage systems.

Switzerland's Largest Bank Chooses an Electronic Filing System from ELEX

ELEX Information System SA, developer of the ELEX Electronic Filing System was selected by the Union Bank of Switzerland to supply an Electronic Document Image Management system for Signature Control. ELEX implemented the Signature Control application using EEF (ELEX Electronic Filing) in a Distributed, Interoperable Wide-Area network, featuring Sun UNIX Servers and UNIX, MS-Windows and X-Terminal clients.

"This is a perfect illustration of our powerful Electronic Filing concept" said Avigdor Luttinger, Managing Director of ELEX. "With our unique combination of Information Object Management, Database Application Generator and Open Systems Client-Server implementation, we were able to provide the UBS with the working prototype in response to every question raised during the Vendor Selection and Evaluation process."

Nissim Avershal, Elex's President added; "EEF goes beyond Document Image Management, offering for the first time Global Information Management that combines Structured (Database) and Unstructured (Image, Voice, Text,...) information in a coherent application driven form."

For product and VAR information

Elex proposes to all those organizations and VAR currently involved in Global Information Management projects to cooperate with us in all stages of the project, from the definition of the needs, helping to define the RFP, to supplying technologies for a running project. We will even take charge of failed or distressed projects!

Call Mr. Lars Bratt (022-738-1188) in Switzerland, or Mr. Robert Verheijen (415-325-8071) in the U.S.A.
We are awaiting your call, it will probably change the way you are currently dealing with information.

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The Global Information Management Company

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- time-slicing can be activated
- timer interrupt rate of 0.1 to 55 ms
- high-resolution interval timer (1 µ sec)
- activate or suspend tasks out of interrupt handlers
- programmable interrupt priorities
- supports math coprocessor and emulator
- inter-task communications using semaphores, mailboxes, and message-passing
- keyboard, hard disk, floppy disk idle times usable by other tasks
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- supports up to 36 COM ports (DigiBoard and Hostess boards)
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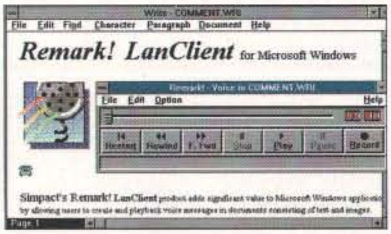
What's New



Remark! LanClient for Microsoft Windows

Simpact's Remark! LanClient product adds significant value to Microsoft Windows applicatio by allowing users to create and playback voice messages in documents consisting of text and images.

ADD VOICE TO WINDOWS ▲ DOCUMENTS

A voice-technology package, Remark lets you embed voice messages within documents and distribute them across networks. Remark voice-enables OLE-compliant applications without the need for a proprietary voice-mail system by using your company's existing LAN and PBX telephone system (single-line system, £3849; each additional line, £3599) via a voice server.

If users wish to add a voice message to a Windows document, they select the Insert Object option from the edit menu. Using OLE technology, Remark orders the telephone system to dial you so that when you pick up the phone, you can record a message on the server. A window with menu functions, such as pause and playback, lets you refine a message before Remark embeds a telephone icon in the document; the icon is a pointer linked to the voice file, which is saved at the server. On opening the document, you can hear the accompanying message by clicking on the relevant icon, which is played back via your phone. European Software Publishing (Maidenhead, U.K.) also offers a Remark Software Developers Kit (£2699), which lets you build custom applications.

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WINDOWS IN HEBREW

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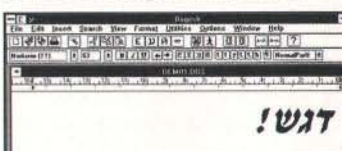
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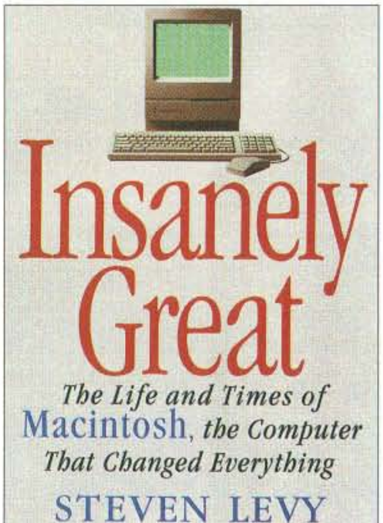
The Genesis of the Mac



TOM THOMPSON

It seems like only yesterday when I bought my 128-KB Macintosh, early in 1984. Today, it's hard to believe the Mac is 10 years old. *Insanely Great* by Steven Levy both describes and celebrates the Mac's birth.

Levy's book does a good job in two areas. First, it presents a brief history of the Mac's technology roots. Much of what became the Mac evolved out of research by Doug Engelbart and Xerox PARC's (Palo Alto Research Center) work on GUIs. This work was applied by Apple engineers to the now-defunct Lisa computer. Much of what made the Lisa a good machine in turn found its way into the Mac.

Second, *Insanely Great* chronicles the personalities of the design team and the pressure-cooker environment under which all such teams labor. You discover that the Mac's genesis was a tumultuous one. It started out as a skunk-works project by Jef Raskin to build a low-cost computer and was actually canceled several times. We get glimpses of the technical hardware wizardry of Burrell Smith, and of Andy Hertzfeld's and Bill Atkinson's inspired software craftwork. Of course, the book also documents working for the mercurial Steve Jobs, who took the project over after winning the political infighting with Raskin.

While Levy does a commendable job covering the people, he goes astray with the technology. Perhaps in targeting a general audience, some of the technical points he tries to make are muddled at best. Some are downright wrong.

For example, Levy dismisses NASA's space program because its "main benefits seem to have been Teflon, Tang, and a stack of very cool photographs." He credits ARPA funding with promoting the growth of software technologies that evolved into word processors, spreadsheets, and the like. The point he misses is that the space program required contractors to cram lots of electronics and machinery into small spaces. These efforts accelerated—by a decade or more—the fabrication techniques used to produce microelectronics. In turn, this sired microprocessors, RAM, and hard drives much smaller than a washing machine. While ARPA funds might have spawned practical software, NASA funds ultimately created the hardware that runs this software, while fitting it all on a desktop and without requiring a government grant to own it.

Sorry, Steven: The original LaserWriter used a 68000 processor, not a 68020. In documenting the start of desktop publishing, he's correct that Aldus PageMaker was the crucial software component. But his mention of the LaserWriter seems merely coincidental to desktop publishing, not crucial to it (which it was). And he fails to mention the contribution of AppleTalk (now LocalTalk), a plug-and-play network that justified the purchase of the expensive LaserWriter for desktop publishing because it allowed several people to share it. (A serious omission.)

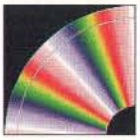
Insanely Great makes for great reading and documents the happenstance creation of one of the decade's most innovative computers. However, marred as it is by technical inaccuracies, the book is only decent, not insanely great. ■

INSANELY GREAT

Steven Levy
Viking Press
ISBN 0-670-85244-9

$19.95

Tom Thompson, a senior technical editor at large, specializes in Macintosh coverage. You can contact him on the Internet or BIX at tom_thompson@bix.com.



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Time and again, I'm impressed with the ingenuity of programmers, especially when they're given free reign with the huge amount of storage provided by a CD-ROM. Maris Multimedia has devised a CD-ROM (Mac and Windows versions are available) that functions as a planetarium-cum-sky chart-cum-sky atlas-cum-dictionary. When Redshift starts, it presents you with a realistic map of the night sky, keyed to the computer's clock and date. The program uses a catalog of 250,000 stars to accurately reproduce each one's color and position. Information on 40,000 deep-sky objects is also provided.

Clicking on a star gives you its SAO (Smithsonian Astrophysical Observatory) number, proper name, Bayer name, Flamsteed name, right ascension, declination, and a host of other information. Clicking on a button overlays the view with the constellations. An orbital mechanics engine positions the planets for anytime between 4000 B.C. and A.D. 11,000, using data from the Jet Propulsion Laboratory. A menu choice gives you access to digitized photos of the planets, their moons, and interesting deep-sky objects (e.g., the Pleiades and the Orion nebula). Hypertext links in the photo gallery connect to entries in the *Penguin Dictionary of Astronomy*. A movie gallery has footage of noteworthy events, such as when the Lunar Excursion Module touched down on the moon.

One neat feature is the program's ability to place you in the vicinity of any planet in the solar system. You can zoom in or out, hang out around a planet's equatorial plane, or sweep up for a view over the polar regions. The 3-D planetary images are created from photo images returned by the *Voyager* spacecraft. It's awe-inspiring to watch Jupiter's Great Red Spot crawl across the planet, and abruptly one of the moons—Io—floats across the scene. Redshift is a technical achievement, serving up impressive views of the sky with amazing accuracy. Amateur astronomers will love this program.

—Tom Thompson

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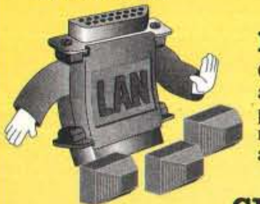

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LEGAL ADVICE

THE SOFTWARE DEVELOPER'S AND MARKETER'S LEGAL COMPANION: PROTECT YOUR SOFTWARE AND YOUR BUSINESS
by Gene K. Landy Addison-Wesley, ISBN 0-201-62276-9, $34.95 (with disk)

If you're in business, you must be aware of certain legal requirements. *The Software Developer's and Marketer's Legal Companion* by Gene K. Landy is a step-by-step guide through the most frequently encountered legalities.

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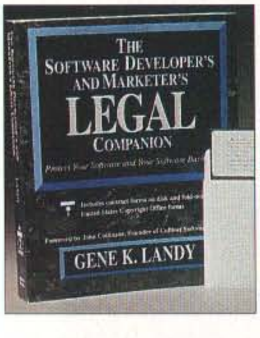


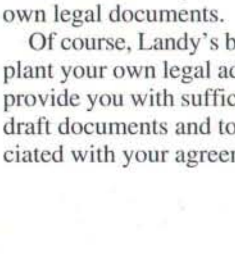
Of course, Landy's book will not supplant your own legal adviser. But it will provide you with sufficient background to create your own first-draft documents and to be aware of the legal implications associated with your agreements.

—Raymond GA Côté

LAPTOP REPAIR

MAINTAIN AND REPAIR YOUR NOTEBOOK, PALMTOP, OR PEN COMPUTER by Stephen J. Bigelow Windcrest/McGraw-Hill, ISBN 0-8306-4455-5, $18.95

Repairing small computers is not a task for the fainthearted. The electronics are highly integrated and tightly packed within the case. Expensive tools are often required to troubleshoot the problem and perform the repair. Yet, you can easily diagnose and fix many problems yourself with just a few common tools.



Maintain and Repair Your Notebook, Palmtop, or Pen Computer covers both the hard and easy problems in a clear, methodical manner. With nerve and a well-stocked workshop, you can avoid calling for help in many cases. The author takes you as far as you want to go and doesn't hesitate to tell you when you should get professional help.

What I found even more valuable than the repair tips, however, was the excellent material on how components of small computers work—everything from batteries to storage devices to mice. As a reference alone, this book is worth the $18.95 price. ■

—Michael Nadeau

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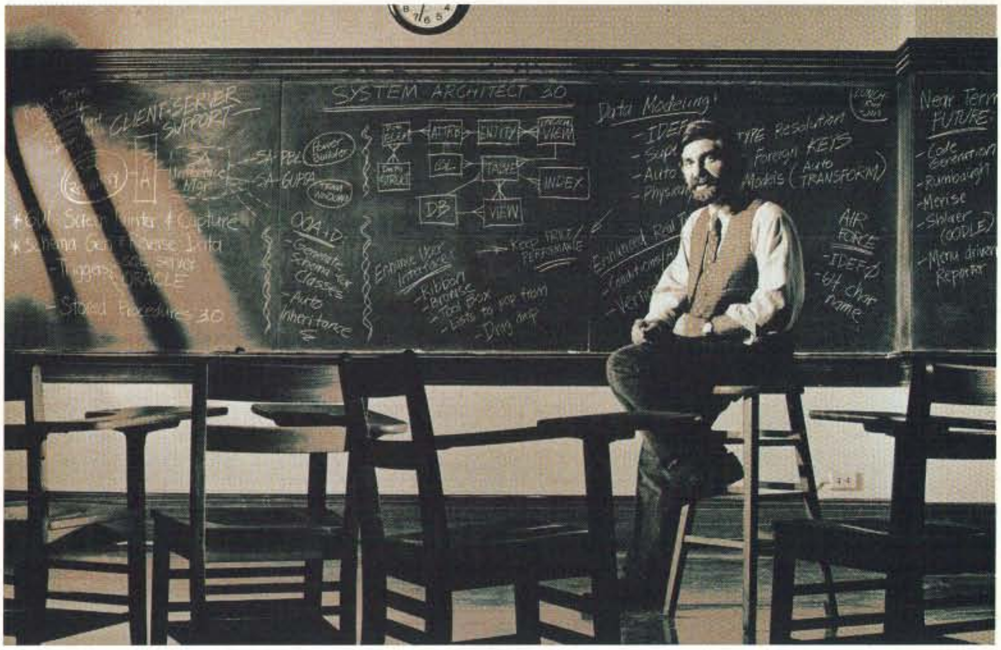

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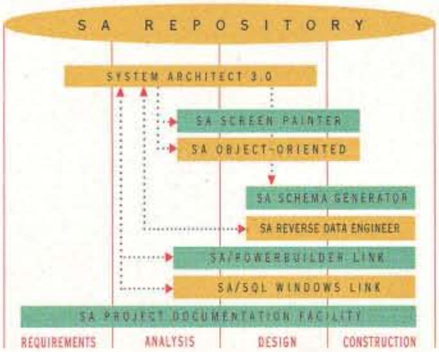

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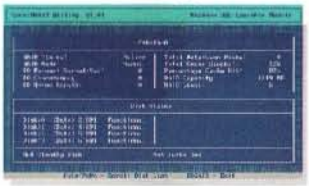

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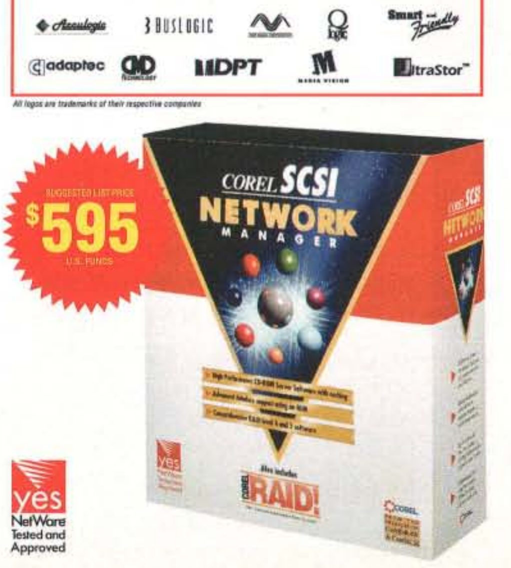

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The Macintosh at 10

Regarded initially as a "toy," it's obvious today that the Mac changed the direction of computing for the better

TOM THOMPSON

SCOTT PARKER / AVIS STUDIO © 1994

This month marks the tenth anniversary of the Apple Macintosh line. Although few took it seriously during the early years, in many ways the Mac defined what a desktop computer should be. Apple pioneered many concepts that users now take for granted.

The ideas of cut-and-paste, undo, point-and-shoot menu selection, picking the best typeface for a document, dropping a graphic into a page, and other common operations were first promoted by the Mac 10 years ago. While many of these ideas drew on work done at Xerox PARC (Palo Alto Research Center), Apple refined and popularized them. The Mac also ushered in new technologies and new expectations that go beyond ease of use, such as plug-and-play expansion boards and networks, remote access, and 24-bit color editing and printing.

The Mac's trendsetting days are not over. Today, the AV-series Macs are the first mainstream desktop systems to offer video capability and voice control as standard equipment. The PowerBook line of notebooks brings a new level of usability to portable computing. And Apple continues to be a driving innovative force in building systems for the graphic arts.

Today Apple is at a crossroads. It is in the process of moving the Mac from its traditional Motorola 680x0 processor to the new PowerPC that the company codeveloped with IBM and Motorola. Apple is also a pioneer in the emerging PDA (personal digital assistant) category with its Newton line. So now is a good time to look back at the Macintosh milestones and place their significance in perspective.

The original Macintosh design team. Left to right: Andy Hertzfeld, Chris Espinosa, Joanna Hoffman, George Crowe, Bill Atkinson, and Jerry Manock. The Mac's high-quality WYSIWYG output was possible because everything on-screen—including text—was a bit-mapped graphic.

Descended from Lisa

In 1983, Apple introduced the Lisa, its successor to the company's aging Apple II line. The Lisa's most innovative aspect was its GUI-based operating system, with windows, icons, and menus. The system's consistent interface with data-as-a-concrete-object metaphor promised ease of use for the office worker. However, its hefty price tag of $10,000 was hard to handle.

A year later, Apple brought out the Macintosh. It was smaller, faster, and—most important—cost $2495. It borrowed a lot from the Lisa, including the GUI and mouse. The Lisa was discontinued in 1985, but its influence lives on inside the Mac, which has gone from a small closed system to a variety of forms: tower systems, small desktop units, and notebooks. Most PCs sold today offer a mouse and run Windows—a tacit approval of the concept of a consistent, user-friendly interface that the Lisa and the Mac pioneered.

Compared with other personal computers of its time, the original Mac was a bit anemic in some ways while excelling in others. For example, few personal computers offered even one built-in serial port, yet the Mac had two of them. More significant was how Apple made use of the system ROMs. The Mac's ROMs were downright massive compared to those of other personal computers. While the IBM XT had 48-KB ROMs, they contained mostly BASIC. Much of the Mac ROM code came from

1984: The first Macintosh borrows the Lisa's mouse and GUI. Other features included a 7.83-MHz 68000 processor, a single-sided 3½-inch floppy drive that could hold 400 KB of data, 64-KB ROMs, and 128 KB of RAM. Price was $2495.

the Lisa and was distilled down into tight assembly code by Bill Atkinson (who wrote the Lisa's graphics engine) and Andy Hertzfeld.

These ROMs supplied an array of routines known as the Mac Toolbox. Related Toolbox routines were collected into groups called Managers, such as QuickDraw (the graphics engine), the Device Manager (which dealt with hardware at a high level), the Window Manager, the Menu Manager, and the Font Manager. These Managers supplied hardware-independent functions that programmers used to communicate with devices, create windows, handle a menu selection, change a font, or establish a network session.

In short, the Mac Toolbox defined an API years before the term was coined. Nowadays, programmers are familiar with an army of competing APIs: Windows, NextStep, and Motif. However, the Mac does a better job of integrating the various services, such as memory and printers, and it places most of the API in ROM. There the Mac API makes fewer demands on memory and disk space. However, its entry points are located in RAM, so that RAM patches can fix bugs or enhance certain services in the API.

In retrospect, the 128 KB of RAM was inadequate for the memory-intensive GUI. It was assumed that since Mac applications would be making heavy use of the ROM-based Toolbox, less RAM would be needed for actual user code. To make the best use of the limited memory, a Memory Manager could load or purge sections of program code on demand. This had important consequences for both programmers and users.

For the Mac programmer, it meant that code had to be written using PC-relative addresses. That's because the Memory Manager might reload the code into different areas of RAM. On the 68000 processor, PC-relative displacements were restricted to 15 bits (the 16th bit was a sign bit, used to determine the direction of the jump), so these chunks of code—called *code segments*—were limited to 32 KB. The Memory Manager might also shuffle crucial data structures around in memory to make an opening for a code segment.

The proper way to address these structures was through handles. Programmers who, for performance reasons, used these handles just to set up pointers to these data structures got a rude surprise when the Memory Manager, going about its duties, rendered the pointer useless by relocating the data structure elsewhere. For programmers used to the absolute addressing schemes of earlier personal computers, this sort of behavior was maddening. It didn't help that you had to learn about an event-driven interface that let the user do anything in any order, or that you needed a Lisa to develop code.

The use of PC-relative code design was prescient, since it allows applications to function in a multitasking or virtual memory environment. The 15-bit branch displacement limit was expanded to 32 bits in the 680x0 processors; this simplifies code design unless the application has to run on the older 68000 Macs. And the Mac has a wide variety of native development tools, with languages from BASIC to C to Forth. Several vendors offer tools with visual programming interfaces, such as Mainstay's Visual C, Zedcor's Future Basic, and Prograph Internationals' Prograph.

Users eventually saw a silver lining, too. The combination of the Memory Manager and PC-relative code enables the Mac environment to run efficiently in far less memory than Windows needs.

One side note on the original design is that Apple used the top 2 bits of the 68000 processor's 24-bit address lines as chip selects for RAM, ROM, I/O, and the floppy drive subsystems. This trick partitioned the Mac's 16-MB address space into four sections: The lower 4 MB was for RAM addresses, the next 4 MB was for ROM addresses, the next 4 MB was for I/O hardware, and so on. Therefore, the ROMs were located just above 4 MB. This location blocked memory expansion beyond 4 MB in the Mac Plus and Mac SE. However, for roughly the same reasons, the PC design suffered the same problem. The PC's ROM, I/O, and video memory were mapped into the upper 384 KB of the Intel 8088's 1-MB address space, so that available RAM topped out at 640 KB. This created the "640-KB barrier" that plagued PC software design for years.

Networking

In January 1985, Apple introduced the Macintosh Office. This consisted of a low-cost LAN and a LaserWriter laser printer. At $6995, the LaserWriter cost more than several Macs, but its price was a lot better than the $50,000 commanded by commercial laser printers at the time. The AppleTalk LAN allowed you to justify such a printer because you could easily share it among several Macs.

This 203.4-Kbps LAN was later renamed LocalTalk, and its strength was that it used low-cost components and featured a plug-and-play setup—necessary since the Mac was a closed system. You simply plugged the network connectors into each Mac's printer port and into a LaserWriter, ran cable between the connectors, and you were done. LocalTalk used a CSMA/CA scheme to attach and map the computers into the network. The network connectors were self-terminating, so you could add or remove Macs from the setup

Famous Mac Firsts

The Apple Macintosh pioneered the use of many features on desktop and portable computers that people now take for granted.

- **Cut-and-paste**
- **Undo**
- **Point-and-shoot menu selection**
- **Built-in video**
- **Voice control**
- **The API**
- **Built-in networking capability**
- **Built-in SCSI**
- **Plug-and-play design philosophy**
- **Dynamic memory allocation**
- **Hypertext**
- **24-bit color capability**

Chris Espinosa: "Apple would have been caught in a bruising price war in 1987 instead of in 1992 if we'd have licensed the ROMs freely. We would have had to cut our margins and expenses earlier and wouldn't have been able to fund a lot of development that brought us to where we are today—such as System 7, the Powerbooks, and the AV technology."

without bringing the network down.

Apple further refined the plug-and-play network concept in 1991 with the introduction of self-terminating Ethernet modules for thick, thin, and 10Base-T cables. In many cases, you could set up a high-speed Ethernet network for an office of Macs in minutes, without getting involved with hardware configuration or IP addresses. Also, System 7's built-in peer-to-peer networking services meant you could create workgroups instantly by setting passwords and access privileges with a few clicks in a Control Panel on each Mac.

While plug-and-play is touted as the Next Big Thing in the PC world, the Mac embraced the concept as its basic design philosophy and has been providing it to users for years. This is evident in the Mac's networking services and in other areas.

The Genesis of Desktop Publishing

In early 1985, many people considered the Mac a curiosity. It was easy to use, but otherwise it offered no compelling advantage over a faster, if arcane, PC. That attitude changed in the summer with the arrival of Aldus PageMaker. It was the first successful page-layout program, and it let you quickly flow text and add graphics to "virtual pasteboards" for designing a newsletter. Furthermore, it let you do this without rocket science or knowing too much of the conventional production details.

The troika of PageMaker, an easy-to-connect LAN, and a shareable laser printer that could churn out camera-ready copy suitable for newsletters and other low-cost publications gave the Mac a unique capability. There were workstations that could manage the same feat, but not with the Mac's ease of use and penchant for visual fidelity between the screen and output.

The Mac was hardly two years old when it gave birth to desktop publishing. Today, DTP is a huge, multimillion-dollar industry, no longer limited to newsletters. Newspapers rely on it to add late-breaking news to their front pages. Magazines use DTP to expedite the creation of the magazine, dropping in text, artwork, and scanned images from a medley of sources.

A SCSI Pioneer

The Mac Plus, introduced in January 1986, was the first personal computer to provide embedded SCSI. However, Apple goofed in its SCSI driver implementation. In a SCSI transaction, an initiator (usually the computer) issues a request to a target SCSI device. The target then issues subsequent SCSI commands to the initiator, completing the initiator's request. In other words, the target drives the transaction. Apple got it backward, having the initiator drive the transaction. This caused problems with early SCSI peripherals, but Apple can be excused as a pioneer here: SCSI itself wasn't formally adopted as an ANSI standard until June 1986. It didn't help that third-party vendors had different interpretations of the standard.

SCSI's high-speed interface and simple-to-configure design made it a natural fit to Apple's plug-and-play philosophy. Despite initial problems during 1986, the Mac's SCSI capability fostered development of easy-to-connect SCSI peripherals, such as third-party hard drives and scanners. The Mac is responsible for the wide acceptance of SCSI in the computer industry today, in part because it proved SCSI's versatility as a low-cost peripheral expansion bus, but also because other computer vendors wanted to tap into the ready-made market of Mac SCSI peripherals. Today, SCSI pervades the industry, serving as a peripheral bus for PCs and workstations. Many hard drives and CD-ROM drives use SCSI because it allows them to connect to any hardware platform.

Bringing Color to the Desktop

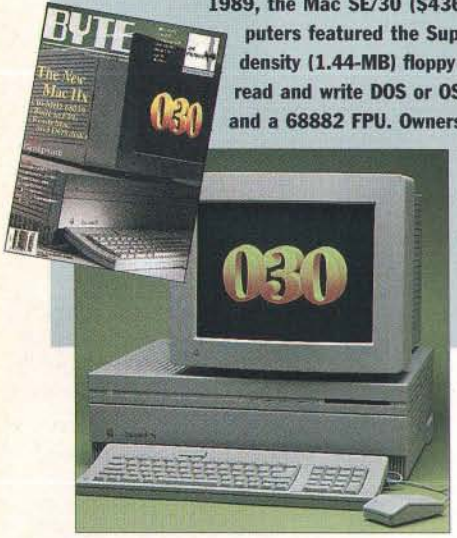
In 1987, Apple both boosted the power of the Mac and discarded the closed-system concept with the introduction of the Mac II and Mac SE. The Mac II featured 256-KB ROMs that added more text-handling capabilities, plug-and-play configuration software for the NuBus boards called the Slot Manager, and Color QuickDraw. Suddenly, the Mac became respectable: Storage problems were a nonissue due to internal or external SCSI drives; you could expand the systems easily using plug-in boards; and the Mac II's color capabilities easily blew away those of existing PCs.

The Mac II fostered the growth of color-output devices, since many users wanted to get on paper what they saw on their screens. Within a year, QMS provided a desktop solution with the ColorScript 100, a PostScript-clone thermal-wax color printer. It was a tad pricey, but for some companies the printer could pay for itself in a year by eliminating the costly errors that occurred when complex color files were sent to a typesetting service.

The stampede of color printers that followed—ranging from high-end PostScript printers to low-cost ink-jets—expanded

1987: **The Mac II used an internal SCSI hard drive, a 16-MHz 68020 processor, and a 68881 FPU as standard equipment. It had eight SIMM sockets that allowed RAM expansion to 128 MB. It also had six NuBus slots for expansion boards. A Mac II with a 40-MB hard drive cost $5498. The Mac SE kept the compact form of the original Mac but added a SCSI hard drive and an expansion slot called the Processor Direct Slot (PDS). A Mac SE with a 20-MB hard drive cost $3698.**

PHOTO OF CHRIS ESPINOSA BY PETER STEMBER, COURTESY OF APPLE COMPUTER, INC. © 1994



1988: Apple migrated the Mac to the 68030 processor, by introducing first the Mac IIx ($7769) and then, in January 1989, the Mac SE/30 ($4369). These computers featured the SuperDrive, a high-density (1.44-MB) floppy drive that could read and write DOS or OS/2 floppy disks, and a 68882 FPU. Owners of Mac IIs and SEs could upgrade to the new machines with a floppy drive and main logic board swap.

the Mac's ability to supply color in DTP output and helped make the Mac a serious replacement for the artist's traditional palette and paint. It helped that the Mac's plug-and-play Slot Manager made adding expansion boards a snap. Most professional artists liked the Mac's set-up-and-go design, since they would rather start drawing than try to figure out how to set up a high-resolution board's jumpers for a PC. And if their monitor proved too small for their work, they could expand the total screen size by simply plugging in another display board and monitor.

Software Strides

The original Mac could use 128 KB of RAM because as the software engineers moved Lisa software components to the Mac, they stripped out the multitasking features. Only one application ran at a time on the Mac, except for Desk Accessories, small "applets" that ran concurrently because they masqueraded as drivers. However, as memory became more plentiful, the multitasking issue resurfaced.

The answer was MultiFinder, written by Erich Ringewald and Phil Goldman. This ingenious bit of software provided cooperative multitasking by patching certain Toolbox routines in the Mac OS, and the MultiFinder application managed loading and context switching of applications.

The reasons MultiFinder worked at all are several-fold: First, because Mac applications frequently called the Toolbox event handlers, these handlers served as doorways by which the thread of execution could be passed to other applications. Second, as execution moved to another application via the modified event handler, MultiFinder took notice of this and preserved certain non-reentrant system globals used to maintain the application's environment. These values were restored when control returned to the application. Finally, the same PC-relative code that initially gave programmers fits meant an application could be loaded anywhere in memory and still run.

The icing on the cake was that MultiFinder retrofitted this capability on existing Macs back to the Mac Plus—no additional hardware was required other than a minimum of 2 MB of RAM. While numerous GUIs for PCs and workstations have appeared since then, none offers the seamless level of integration for copying information between applications and the easy ability to select system resources such as networked printers.

1989: The Mac SE/30 was the first high-performance compact Mac design. It had a 16-MHz 68030 processor and a 68882 FPU. Because the screen display used separate VRAM rather than main memory as in the original design, better bus throughput was achieved.

HyperCard: GUI Programming for the Masses

The Mac was hard to program. Bill Atkinson crafted HyperCard, which he called "a software erector set," to eliminate this hurdle. It implemented a card-stack metaphor that enabled users to browse through and manipulate information. HyperCard provided a set of built-in editing tools and a natural-language programming script called HyperTalk. With these tools and HyperTalk, the average user could collect, organize, and store information in HyperCard stacks in any fashion.

HyperCard and MultiFinder were introduced in August 1987 and were bundled with every Mac shipped. In a demonstration of its robust design, HyperCard was used to operate information kiosks that supplied show information. It introduced ease-of-programming to the average Mac user and promoted to computer users the concept of hypertext links. Nowadays, computer users understand that phrases that stand out in a document (perhaps by being in a different color or underlined) serve as a hypertext link to additional information. HyperCard educated the user on this "intuitive" concept.

32-Bit QuickDraw Arrives

For folks doing serious image and graphics work, the 256 colors displayed by Color QuickDraw's 8-bit color were simply inadequate. Clever display-board vendors such as SuperMac Technologies managed to coerce 24-bit data onto the screen by successively assembling an image's three-color components in a display board's frame buffer.

Apple came out with a revised version of Color QuickDraw in April 1989. Called 32-Bit QuickDraw, it was a patch file that retroactively implemented 24-bit color capabilities on existing color Macs. (The 32-Bit term in the name came about because pixel data was stored as 32 bits even though only 24 of them actually contained color information.) It also let you switch on the fly between 24-bit color (millions of hues), which is suitable for photo-realistic editing, to 16-bit color (thousands of hues), suitable for handling digital video for multimedia. This lets you pick the screen depth

1989: The Mac IIci, Apple's first 25-MHz 68030-based computer, featured built-in video. It cost $6969 with a 40-MB hard drive and used 512-KB ROMs that were "32-bit clean" (i.e., the code was designed to operate in a new 32-bit address space, although it could also operate in the old 24-bit address mode for software compatibility). This ROM code has become the "universal ROM" code used in every 68030-/68040-based Mac since then.

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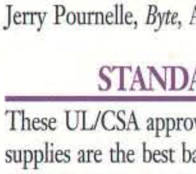

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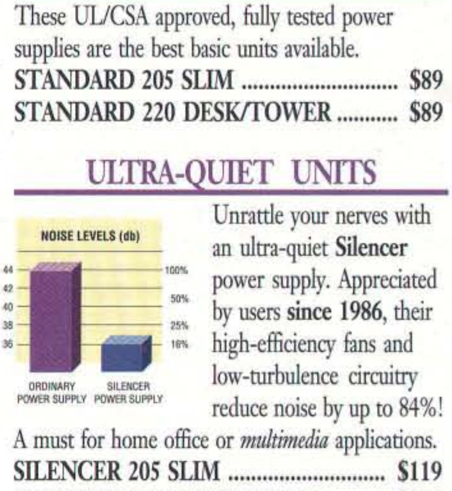

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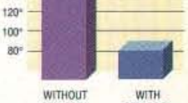

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1990: **Apple changed its direction and introduced the "cheap Macs": the Mac Classic (basically a revised Mac SE), the Mac LC (a Mac II in a svelte housing), and the 20-MHz 68030-based Mac IIsi. These machines represented Apple's intent to expand market share by producing systems priced competitively with PCs. The Mac Classic cost $999, the Mac LC cost $2499 with a 40-MB hard drive, and a similarly equipped Mac IIsi cost $3769.**

that is suitable for the job at hand.

This support of high-resolution color accelerated the Mac's use as a digital-image editor. Now, not only could the Mac lay out the text of magazine pages, it could also edit the high-quality images that went into them. It also let the Mac function as a data visualization tool in scientific and engineering applications.

Again, 24-bit color manipulation wasn't a new concept, but the custom high-end workstations with similar capabilities cost $30,000 or more. The Mac's new capability raised expectations in the PC world: At that time, you typically had only 16 or possibly 256 colors on the screen; today, you can shop for a PC display board that supports thousands or millions of colors.

Portable Lessons and Power

One of the glaring deficiencies in the Mac product line was the lack of a notebook computer. In September 1989, the company introduced the Mac Portable to plug this gap. Unfortunately, the computer barely earned the label "portable," weighing 17 pounds and being the size of a small briefcase. Three things in its favor were the sharp active-matrix display, an integrated trackball, and an 8-hour battery life, thanks to the heavy lead-acid battery.

The Mac Portable turned out to be a dud, sales-wise. However, Apple learned a valuable lesson from it. Two years later, in October 1990, the PowerBooks showed that Apple could pack a Mac into a light, 7-pound notebook form factor. These systems came equipped with a practical set of features, such as a 25-MHz 68030 processor (in the PowerBook 170) and fax and remote-access software.

Nor was the Mac Portable's design effort a total waste: Much of its power conservation software, and hardware tricks such as slowing the processor clock and switching off idle subsystems, found their way into the PowerBook designs. The Apple Remote Access software bundled with PowerBooks let users connect as a remote node to the AppleTalk network in their office. This let them transfer files, print documents, and access databases or schedules the same way they did in the office. The PowerBooks let the on-the-go office worker contact anyone by E-mail, fax, or remote access.

Today, many PC notebook computers imitate the PowerBooks' physical layout, including the integrated trackball. Still, most of them can't match the PowerBooks in the level of software integration.

New Software, New Processors

At the May 1988 Developer's Conference, Apple talked about System 7, the successor to System 6.0.x. It would be a 32-bit operating system offering significant features, such as a new SCSI driver, drag-and-drop printing, a new graphics engine, and built-in cooperative multitasking.

Apple had hoped to introduce System 7 about two years after its announcement in 1988. It didn't turn out that way; it arrived in May 1991—a year late. System 7 improved the user interface in several subtle and effective ways, such as by providing a built-in find function that locates a file on your hard drive or on a network. And while multitasking under System 6.0.x was something of a kludge, a Process Manager in System 7 managed the multitasking environment by handling the creation of memory partitions and loading the applications.

A 7.1 revision of the operating system consolidated fonts into a separate folder, where you installed or removed them by simply clicking on and dragging files. System 7.1 also introduced the concept of a System Enabler—a small file of hardware-specific code—that at boot time sets up the low-level environment so System 7.1 can operate. This lets System 7.1 function without modification even if the hardware changes. This seems like a minor point unless you've tried to install Windows on different machines with different hardware. Whereas a new Mac simply requires a new System Enabler, a Windows user can spend hours trying to massage Windows and DOS drivers to get a combination that works.

Video Killed the Radio Star

Introduced with System 7 was QuickTime, which gave the Mac the ability to control time-based data. For example, QuickTime handled the display of digital video clips and sound, ensuring that both the pixels and sound were synchronized and delivered to the screen at the constant rate demanded by such media. An important point is that QuickTime is a cross-platform technology: A Windows version is available, and Silicon Graphics has adopted QuickTime as a digital format. This lets multimedia applications developers store digital video and sound as QuickTime movies and count on them to function as expected on any platform.

1991: **Along with the PowerBooks, Apple also presented its first 68040-based Macs—the Quadra line. The Quadras started out as 25-MHz 68040-based systems with 1-MB ROMs, 24-bit on-board video, and built-in Ethernet capabilities. The Quadra 700 used a IIci-style form factor, and the Quadra 900 used a tower design. A Quadra 700 with 4 MB of RAM and an 80-MB hard drive cost $6399, while a Quadra 900 with 4 MB of RAM and a 160-MB hard drive was priced at $8499. The latest offering is the 25-MHz Quadra 605, which comes in a slim pizza-box housing and costs up to $1269.**

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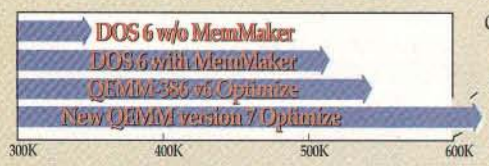

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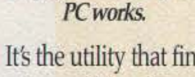

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How we got the chart numbers: CPU—486/33 ALR Power/business VEISA machine equipped with 16 megs of RAM and running MS-DOS 6. Comparisons were done using the following memory managers: QEMM 7, QEMM 6.02, MS-DOS 6 MemMaker. In addition to the driver (or drivers) required by each memory manager, the following drivers, DOS resources and programs were loaded for all comparisons: in the CONFIG.SYS file: SETVER.EXE, DOS=HIGH, FILES=20, BUFFERS=10, STACKS=0,0, MVSOUND.SYS, SNDBK12.SYS, SLCD.SYS, DOS SHELL=statement, in the AUTOEXEC.BAT file: VSAFE, MSCDEX, UNDELETE, LSL.COM, NE2000.COM, IPXODI.COM, NETX OR EMSNETX, MOUSE.COM, SMARTDRV.COM, PRTSCCAP.COM. ©1993 Quarterdeck Office Systems. Trademarks are property of their respective owners.

Digital movies, however, require tons of storage. In anticipation of these storage demands, Apple has heavily promoted the adoption of CD-ROM as a storage medium by offering built-in CD-ROM drives in many of its systems. These drives are dual-speed, multisession drives, unlike the single-speed, single-session drives found in most MPC systems. Apple also supports Kodak's Photo CD digital-image standard and provides a driver that transparently reads Photo CD files. Consumers might not be enamored of digital photography, but businesses that do a lot of image work (e.g., making and printing catalogs) find Photo CDs to be the ideal storage/retrieval format.

Due to the Mac's push on color technology and the availability of dual-speed CD-ROM drives, today you have a choice of interactive CD-ROM titles that can play 16-bit digital video clips. With low-cost MPEG encoders from C-Cube and others appearing, you can expect to see full-screen (640 by 480 pixels), full-motion (30 frames per second) digital movies on CD-ROM soon.

With its AV line of Macs, Apple blurs the boundaries between TV and the computer. Out of the box, AV Macs can drop NTSC, PAL, or SECAM live video into a window on the desktop. Furthermore, with the appropriate software you can snatch a frame of video, or capture video into a QuickTime clip. You can also easily "print" a screen or a running demonstration to a VCR tape. While these capabilities don't come close to those offered by professional equipment, it's the start of the Mac breaking traditional boundaries, transforming itself from a simple personal computer into a communications device. This will accelerate the integration of TV and information services into the desktop computer.

"We used HyperCard to design the Newton interface. We'd sit down with HyperCard and use the drawing tools to sketch out something. We'd tinker with it until we got what we wanted."

— Steve Capps,
Distinguished Engineer

While the original Mac was touted as an "information appliance," after a decade it's clear that the Mac has yet to reach that lofty goal. However, it's well on its way.

The Future

Where does Apple go in the future? It continues to push the boundary on technical innovation. In 1991 it forged strategic alliances with Motorola and IBM to share various hardware and software technologies. The first result of this alliance is the PowerPC RISC processor. RISC systems, though powerful, were simply too expensive for the personal computer market until the PowerPC arrived. The PowerPC bucks this trend with low fabrication costs combined with RISC's high performance.

1993: The video Macs arrive. The Quadra 840AV comes in a short tower design and has 2-MB ROMs and a 68040 processor clocked at 40 MHz. A Quadra 840AV with 8 MB of RAM and a 230-MB hard drive costs $4069. It has built-in live video capture and presentation hardware, and a DSP (digital signal processor) that handles voice recognition and CD-quality stereo sound, plus fax and modem functions.

Apple is basing a line of Macs on the processor. A low-cost PowerPC Mac, combined with IBM PowerPC offerings, could push RISC into the mainstream of personal computing. With the proper System Enabler and a 680x0 emulator, System 7.1 actually runs on a PowerPC-based system.

Apple also continues to work toward replacing its low-level single-threaded operating-system services with a microkernel. The microkernel would provide memory protection, multiple threads, reentrant drivers, and preemptive multitasking. This makes for a more robust environment and lets the operating system manage its resources more effectively. Apple is attempting to do this while simultaneously preserving the existing software base by adding portions of the microkernel piecemeal.

For example, the Quadra 840AV uses a new SCSI Manager 4.3 that not only implements SCSI correctly but is a reentrant driver. Likewise, the ROMs in the PowerPC Mac implement Toolbox routines as DLLs; this will allow multiple threads. Will Mac users be able to use such an operating system on existing hardware? It's possible: Since the Mac SE/30, all 68030-/68040-based Macs have a SIMM ROM socket at the ready. Although most of these Macs have 1 MB of ROM or less, they can address 8 MB (except for the Mac SE/30, which can address only 2 MB). Apple isn't talking about its plans in this area.

Apple has also attempted to jump-start the PDA industry with the MessagePad, the first implementation of its Newton Technology. Newton Technology is a multitasking, object-based operating system. Apple has licensed it to a number of vendors for use in different products, dispelling the technology's proprietary label.

More important, Newton Technology is an information-centric, not document-centric, operating system. Put another way, with Newton Technology you simply deal with information; you don't get caught in the mechanics of handling the information. For example, with the proper application on a MessagePad, you can jot, "Cab $10." The Newton operating system interprets the command, starts an Expense Report application, and drops the value of $10 into a travel expense cell dated for today. On a desktop system, you'd have to launch the appropriate application, locate the proper cell, enter the value, and then attach a date to the value.

Whether or not the MessagePad succeeds, Newton Technology will be a success because it shows us an even better way to work with our computers. That's something that the Mac did only 10 years before. ■

Tom Thompson is a BYTE senior technical editor at large, a long-time Mac user, and a certified Apple developer. You can reach him on the Internet or on BIX at tom_thompson@bix.com.

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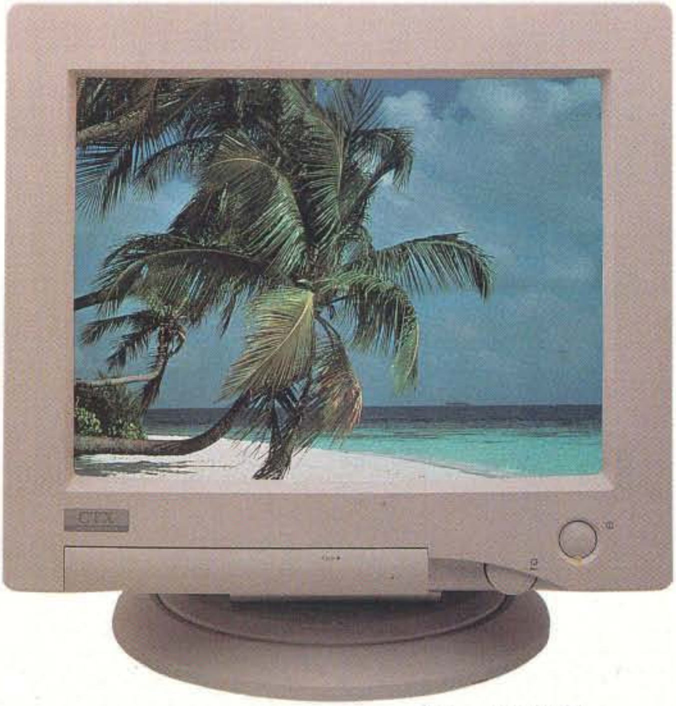

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HOW SAFE IS DATA COMPRESSION?

TOM R. HALFHILL

To paraphrase Aesop, necessity is the mother of compression. If it weren't for the explosive growth in the size of operating systems, applications software, and data files, today's hard disks would be cavernous warehouses with acres of megabytes to spare. In just a few short years, desktop PCs with 40-MB hard drives have given way to systems that rival network servers: 200-, 400-, and even 1-GB hard drives aren't uncommon.

Yet despite the rapidly rising capacities and falling prices of hard disks, not everyone can afford the latest hardware, and some systems can't be upgraded. So it's no surprise that millions of PC users who bought MS-DOS 6.0 last year quickly embraced a new feature called DoubleSpace. Merely by installing some free compression software that ran invisibly in the background, they could virtually double the size of their existing hard disks.

But it wasn't that simple. Almost immediately, Microsoft was besieged by complaints about a myriad of problems, and some users reported catastrophic losses of data. Other people had no trouble at all and enthusiastically endorsed DoubleSpace. The controversy raged on BBSes and on-line services for months, while Microsoft steadfastly denied that DoubleSpace was buggy. Finally, last November, Microsoft released DOS 6.2 with several new safeguards.

Nevertheless, many users remain spooked about real-time data compression. Their fear is fed by persistent horror stories of users who have trashed megabytes of valuable files while using DoubleSpace and other on-the-fly disk compressors. Although in many cases the compression software is an incidental player, the association has been made: Compression is unreliable.

The real problem isn't data compression, though; it's how well the technology is implemented in the operating environment. And no environment is more hostile than that of DOS-based PCs.

PCs are plagued by dozens of "standards" covering everything from video cards to I/O buses. The memory layout resembles a map of the Balkans. TSRs and device drivers fight territorial battles over disputed memory blocks and interrupts. Applications think nothing of bypassing the ROM BIOS to save a few microseconds, and there are a number of versions of the BIOS from different vendors. Software installation programs automatically rewrite critical configuration files such as AUTOEXEC.BAT and CONFIG.SYS, often without notifying

PHOTOGRAPHY: ED JUDICE © 1994

MS-DOS 6.0 with DoubleSpace raised real-time data compression to a new level of visibility. As controversy raged over its reliability, some concerned users retreated from the technology. But the real issue isn't data compression at all; it's how compression is integrated into the operating environment. New approaches promise to make this technology much more foolproof.

the oblivious user. Windows 3.1 layers a multitasking GUI atop a single-tasking, character-based operating system and contributes additional configuration files: SYSTEM.INI, WIN.INI, CONTROL.INI, and more. Different versions of DOS are available from three major companies. Most important, the DOS file system was simply not designed with real-time compression in mind.

Nearly all the troubles that users experienced can be traced to confusion or to odd interactions between the compression software and other parts of the system. That doesn't make the complaints any less serious, of course, but it does mean that the future of data compression is tightly bound to the continuing evolution of PCs. As PCs mature, become easier to use, and consolidate around better standards, data compression will steadily gain in popularity.

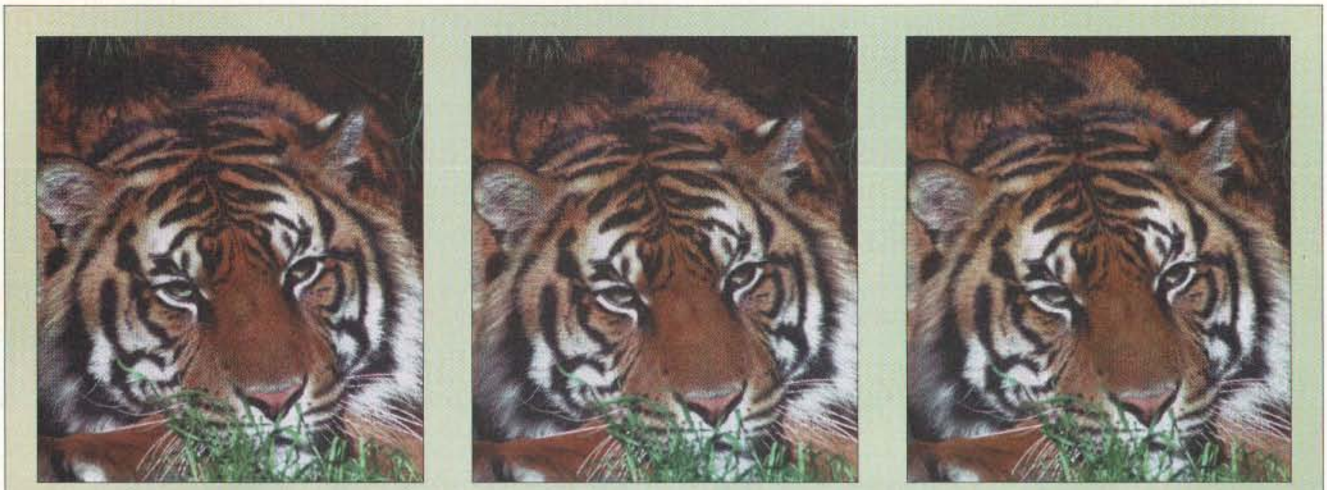
Transparency is the key: Data compression works best when it's completely transparent to both users and software. Today's compression software tries to keep a low profile, but it is frequently shoved into the open by forces beyond its control.

One lasting effect of the DoubleSpace debate is that all makers of compression software are paying even closer attention to safety issues. Current products will continue to improve, and new approaches are being explored.

For instance, some companies are working to move compression into hardware. By integrating the technology with the CPU's I/O bus—and, perhaps, even in the CPU itself—data compression could become as transparent as floating-point math. The goal is not only to conserve hard disk space but also to significantly improve system performance by keeping the data compressed while it moves over the bus to peripherals and networks, and maybe even to main memory.

Compression Goes Prime-Time

The basic concept of data compression is at least as ancient as the Romans, who figured out that the Roman



With lossy compression techniques such as JPEG, image quality declines as the compression ratio goes up. This is because files are compressed by throwing out data. The first image is uncompressed. Maximum compression was used for the last image. The remaining image represents the middle ground between the two.

IMAGE FROM COREL'S PROFESSIONAL PHOTOS CD-ROM SERIES SAMPLER.

numeral *V* required less space on a stone tablet than did *IIIII*. Modern compression techniques are widely used to shrink huge graphics, video, and sound files down to manageable size.

But those types of compression—JPEG, MPEG, Indeo, and the compressors included with QuickTime and Video for Windows—are so-called *lossy* methods; some data is irretrievably discarded when the files are compressed. Lossy compression is unacceptable for critical data, such as spreadsheets, databases, and text. For those types of files, only *lossless* compression will do: Not a single bit of valuable information can be lost during compression or decompression.

Before DoubleSpace, the most popular lossless compression products were the file-level utilities for archiving data on floppy disks and saving time during downloads. One of the leading file compressors for PCs is Phil Katz's PKZip, a shareware program so effective, it can squeeze the complete text of NAFTA (North American Free Trade Agreement) from its normal bureaucratic bulk of 3.3 MB down to a mere 568 KB—an impressive compression ratio of nearly 6 to 1. The resulting file is small enough to fit on a floppy disk or to download from a BBS. Similar utilities are available for Unix and the Macintosh (see the text box "Data Compression on the Macintosh").

But file-level utilities require users to run a program to compress and decompress the file. Some utilities can make self-extracting archives—a single executable file that encapsulates both the compressed data and the decompression program—but it's still not simple enough for casual users. For them, real-time, on-the-fly data compression is a better solution.

Real-time compressors run in the background, automatically shrinking files when they're saved on disk and expanding them when they're loaded. Most real-time compressors set up a compressed virtual drive on the uncompressed host drive, so compressing a file is as easy as saving or copying a file onto the new virtual drive.

For PCs, examples include DoubleSpace from Microsoft; Stacker from Stac Electronics (Carlsbad, CA); XtraDrive from Integrated Information Technology (IIT) (Santa Clara, CA); SuperStor Pro from AddStor (Menlo Park, CA); and DoubleDisk Gold from Vertisoft Systems (San Francisco, CA), which supplied Microsoft with compression technology for DoubleSpace.

In 1991, DR-DOS 6.0 from Digital Research was bundled with SuperStor, thus becoming the first version of DOS to include real-time data compression. Until DoubleSpace came along, however, real-time compressors were mainly confined to a relatively small market of power users. With the release of MS-DOS 6.0, millions of casual users who barely knew the difference between a physical drive and a logical drive were suddenly creating compressed volumes on their hard disks with nary a second thought—some with disastrous results.

Trouble with DoubleSpace?

Data-loss problems are always difficult to trace, and the natural tendency is to blame the last thing installed. With DoubleSpace, most problems seemed to fall into three categories: (1) file corruption caused by bad sectors on the hard disk; (2) puzzling disk-full errors caused by badly fragmented compressed drives or lower-than-expected compression ratios; and (3) subtle interactions with other software, including the SmartDrive disk caching in DOS 6.0.

Microsoft responded by adding several safeguards to DOS 6.2 and DoubleSpace. ScanDisk, a new diagnostic/repair utility, fixes damaged files and automatically scans the hard disk for surface errors before DoubleSpace is installed. DoubleGuard, a new protection option, alerts users if another program or TSR corrupts the RAM-resident portions of DoubleSpace. SmartDrive no longer turns on writeback caching by default. And Microsoft also made it easier to remove DoubleSpace altogether—a paradoxical but popular feature in other compression products.

Despite the safeguarding efforts of Microsoft and others, some users have simply reached the end of their ropes. Steven Polinsky, a lawyer in Ridgefield, New Jersey, says he removed Stacker from the 40-MB hard drive of his desktop PC after experiencing mysterious errors, even though he's not sure Stacker was to blame. Next, he installed DoubleSpace on his laptop computer's 60-MB hard drive but immediately ran into video initialization trouble with Windows. Now, he's reluctant to put either Stacker or DoubleSpace on his desktop PC.

"Overall, I'm a believer in DoubleSpace and in data compression in general," says Polinsky. "But this is my mission-critical computer. It's my billing, my accounting, my research tool, my everything. I can't live without it."

However, most users are so hungry for hard disk space that they're willing to take a little misfortune in stride. Chris Cooper, a software engineer working in Pforzheim, Germany, was not deterred even after CHKDSK failed to fix an error on his DoubleSpace drive: "I backed up, reformatted, and reinstalled everything, and that certainly fixed the problem."

The irony is that data compression is a rock-solid technology. There's no magic

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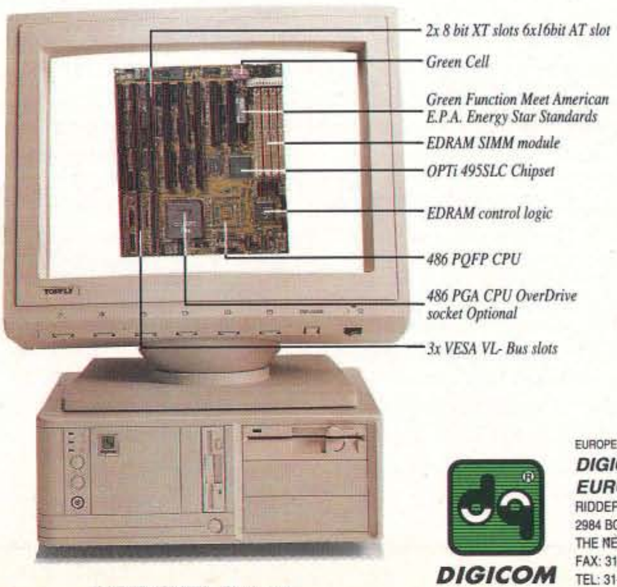
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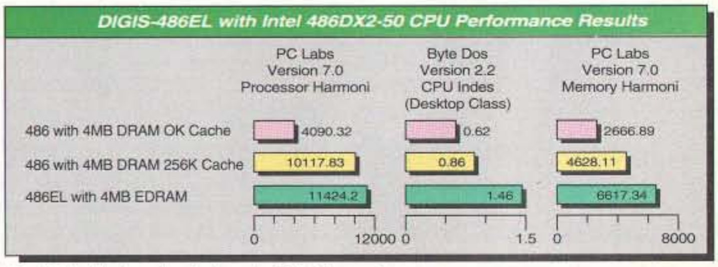

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or voodoo; it's as straightforward and reliable as 2+2 = 4. The comparison is apt because virtually all lossless data-compression products are derived from principles of information theory that were formulated in the 1940s and later refined in the 1970s and 1980s. At its roots, the basic technology of data compression may be the levelest playing field in the computer industry. It is how various companies use compression that makes the difference.

Not Rocket Science

Typically, lossless data compression is based on some variation of the LZ (Lempel-Ziv) or LZW (Lempel-Ziv-Welch) methods, named after Abraham Lempel, Jacob Ziv, and Terry Welch. When adapted for real-time compression, LZ/LZW strikes a reasonable compromise between efficiency and speed. On average, it achieves a compression ratio of about 2 to 1. Compare that to lossy methods such

Data Compression on the Macintosh

Macintosh users have thus far escaped most of the controversy over disk compression that haunts PC users. For one thing, disk compression isn't a standard feature of the Mac operating system as it is with the latest versions of DOS. It's like the PC world before DoubleSpace: You have to buy a third-party product to get compression, so it tends to attract users who are more aware of the trade-offs.

Also, for various reasons, Mac software doesn't require as much disk space as Windows software. Many Macs are still sold with 80-MB hard drives—woefully small by today's PC standards but plenty large for the average Mac user.

Nevertheless, data compression is very much in demand. High-end Mac users tend to be graphic artist professionals who handle truly huge files: A single scanned photograph might easily require 50 MB. File-level compressors have been popular for years, and the Mac counterparts of PKZip include StuffIt Deluxe and StuffIt SpaceSaver from Aladdin Systems (Watsonville, CA); DiskDoubler and AutoDoubler from Symantec (Cupertino, CA); More Disk Space from Alysis Software (San Francisco, CA); Now Compress from Now Software (Portland, OR); and Compact Pro, a shareware program by Bill Goodman from Cyclos (San Francisco, CA).

Unlike PKZip, however, most file-level compressors on the Macintosh can work transparently, automatically compressing and decompressing files as they're opened and closed. In fact, some of these programs constantly scan the disk for uncompressed files and automatically compress them during idle times. Control panels let you decide whether all files on a disk should be compressed or only certain files and folders.

Real-time disk compressors are fairly new on the Mac. Unlike file-level compressors, they install themselves at the device-driver level, similar to disk compressors on the PC. There's one important difference, however: On the Mac, device drivers automatically load into memory from all storage media on the SCSI chain during startup or when a removable disk is mounted. In other words, the compression software is tied to the media, not to the machine. So a service bureau, for example, can read a compressed Syquest disk without installing the compression software on its system.

There are three driver-level products available for the Macintosh: eDisk from Alysis Software; Stacker from Stac Electronics (Carlsbad, CA); and TimesTwo from Golden Triangle Computers (San Diego, CA). TimesTwo replaces the disk's existing SCSI driver with a custom driver that handles compression. Both Stacker and eDisk work with the existing SCSI driver, wedging themselves between the driver and the operating system.

The main advantages of driver-level compressors are that they're less likely to conflict with system extensions (also called INITs), and they're capable of compressing more kinds of files—even the non-ROM portions of the Mac operating system in the System Folder. On the downside, driver-level compressors may be incompatible with other SCSI device drivers.

Macintosh compressors use the same basic compression methods as those on the PC, achieving the same average compression ratio of about 2 to 1. However, the Mac file system shares a limitation of DOS that prevents either platform from exceeding that ratio on large hard drives, even with files that are highly compressible.

The problem is that both DOS and the Mac address their allocation blocks (called clusters on the PC) with a 16-bit number, so the maximum number of blocks on a drive—regardless of its capacity—is 65,536. Therefore, drives larger than 512 MB cannot use a minimum block size of 8 KB or less, because there aren't enough addresses. On a 1-GB drive, the block size grows to 16 KB; on a 2-GB drive, it expands to 32 KB.

This results in wasted space on large drives, because a block can't hold more than one file, so even a tiny file requires a whole block. One solution is to partition large drives into smaller logical drives. Each logical drive can address 65,536 blocks, so the blocks can be smaller.

On a compressed drive, block sizes are variable, so less space is wasted. However, it's possible to run out of allocation blocks before running out of actual physical space. This happens when the overall compression ratio on a large drive exceeds 2 to 1. Individual files can be compressed at much higher ratios, of course, but the average compression ratio across the entire disk cannot exceed that limit.

For example, let's say you compress a 512-MB drive. Its virtual size (based on an average 2-to-1 compression ratio) is 1024 MB, or 1 GB, with 16-KB blocks. Now you start filling the drive with highly compressible files that achieve a ratio of 4 to 1. There's enough physical space on the drive to store 2-GB worth of those files, but you'll get a surprising disk-full error after 1 GB. Why? Because the drive is limited to 65,536 allocation blocks, and it would need 131,072 of those 16 KB blocks to store 2 GB.

In practice, this barrier is not a serious problem because the average compression ratio for a typical mix of files rarely exceeds 2 to 1. But as drive capacities continue to climb and compression software keeps improving, this limitation is sure to be removed in future versions of DOS and the Mac OS.

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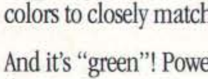

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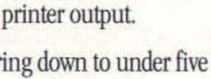

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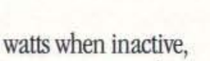

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as JPEG, which deliver compression ratios as high as 100 to 1, if you aren't too picky about quality.

Compression works better on some types of files than on others, and some files cannot be compressed at all. Compression algorithms depend on repeating patterns of data, so they don't work on files consisting of random data. Typical examples include encrypted files (the better the encryption, the more random the data) and files that have already been compressed (because randomization is a byproduct of compression; otherwise, you could repeatedly compress a file until it was squeezed down to a single byte).

Compression algorithms can be optimized for different data types. One method, RLE (run length encoding), works well on files with long strings of repeating bytes. For example, if a portion of a graphics file has 100 white pixels in a row, an RLE compressor might save 1 byte that indicates "white" and another byte that indicates "100." The decompressor knows that the first byte represents the color and that the second byte tells how many pixels of that color will follow. Even though RLE is a good choice for compressing a graphics file, it would be a poor choice for a text file.

For that reason, some compressors analyze the uncompressed data to choose the optimal compression method. However, none of the real-time disk compressors, such as DoubleSpace, does this. Analysis takes time, and the extra compression isn't worth the performance hit.

Instead, DoubleSpace and other real-time disk compressors use a *sliding dictionary* form of LZ compression, no matter what kind of data the file contains. To shrink a file, the compressor looks for repeating patterns. It then replaces each pattern with a pointer that refers back to an earlier occurrence of the same pattern, as well as a token that specifies the length of the pattern. Later, when the file is decompressed, the pointers and tokens are replaced with the original patterns.

Microsoft cites this example: "the rain in Spain falls mainly on the plain." Counting spaces and the period, this phrase normally requires 44 bytes. But it contains several repeating patterns, including *ain* and *the*. DoubleSpace would encode the phrase as follows:

```
the rain [3,3]Sp[9,4]falls
m[11,3]ly on [34,4]pl[15,3].
```

continued

Data Loss: A Cautionary Tale

HOWARD EGLOWSTEIN

Catastrophic data losses caused by disk compression are rare, but definitely happen. Usually, it's not directly the fault of the compression software, but rather is caused by an unexpected interaction between various components of the system. A typical example is my recent experience with Microsoft's DoubleSpace and AddStor's DoubleTools running on a Toshiba T4600C laptop computer.

DoubleTools seemed like an interesting product—it provides finer control over the internal workings of DOS 6's compressed volumes and promises better disk repair capability than the standard utilities included with DOS. I'm not a fan of disk compression in general, but I make regular backups of my data and had nothing to lose.

I installed DoubleSpace on the Toshiba T4600C's 200-MB hard drive, then proceeded to install DoubleTools. As part of the installation procedure, you're given the option of sticking with the standard Microsoft DBLSPACE.BIN driver or replacing it with AddStor's enhanced driver. The enhanced driver gives DoubleTools better access to the internal guts of the compressed volume and allows it to analyze things more thoroughly. The AddStor manual recommends using it, so I did. After installation, you must reboot to load the new driver.

Until this point, everything had gone well. As the Toshiba rebooted, however, the AddStor driver tried to examine my hard drives. It found drive C and then looked at drive D, which was actually Toshiba's PCMCIA driver for a fax modem card. Because the Toshiba driver also supports PCMCIA hard drives, it has to load as if it were a disk drive. I didn't have the PCMCIA drive installed, so accessing drive D caused a "Not ready reading drive D:" error. The DoubleSpace driver paused for quite a while during bootup as it dealt with this nonexistent drive.

I started Windows and loaded the DoubleTools configuration utility to tell it not to bother dealing with drive D. The utility's pick list recognized the two removable drives on the Toshiba (the floppy at drive A and the PCMCIA drive D). I selected drive D from the list. The screen went blank, but then displayed the following message: "Serious error occurred reading drive H:. Press any key to continue." The machine froze, and cycling the power was the only way to get it back.

When the machine rebooted, the DoubleSpace compressed volume was badly corrupted; no standard recovery tools could read it. The only fix was to reformat the drive and reload everything. Just to make sure this wasn't a fluke, I tried the whole exercise again and got the same failure.

What happened? It's not exactly DoubleSpace's fault, and it is not really AddStor's fault, either. (DoubleTools did not expect to find a valid yet nonexistent drive.) Is Toshiba to blame? That depends on whether the problem was caused by the driver or the application's inability to handle a serious error. At press time, this issue was still uncertain.

Any way you look at it, the failure was catastrophic. If this hadn't been a review machine (and backed up at that), I could have lost a great deal of work simply by installing a tool designed to make using my disk safer. That's pretty scary.

There were at least three ways to resolve the problem: remove the fax modem and PCMCIA device driver; uninstall DoubleTools; or just give up on DoubleSpace altogether. Because the modem is handy, and using DoubleSpace without decent recovery tools seemed foolhardy, I decided to uninstall both DoubleSpace and DoubleTools.

Howard Eglowstein is a testing editor for the BYTE Lab. You can reach him on the Internet or BIX at heglowstein@bix.com.

Why do they call it a dongle?

He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

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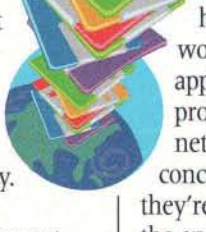

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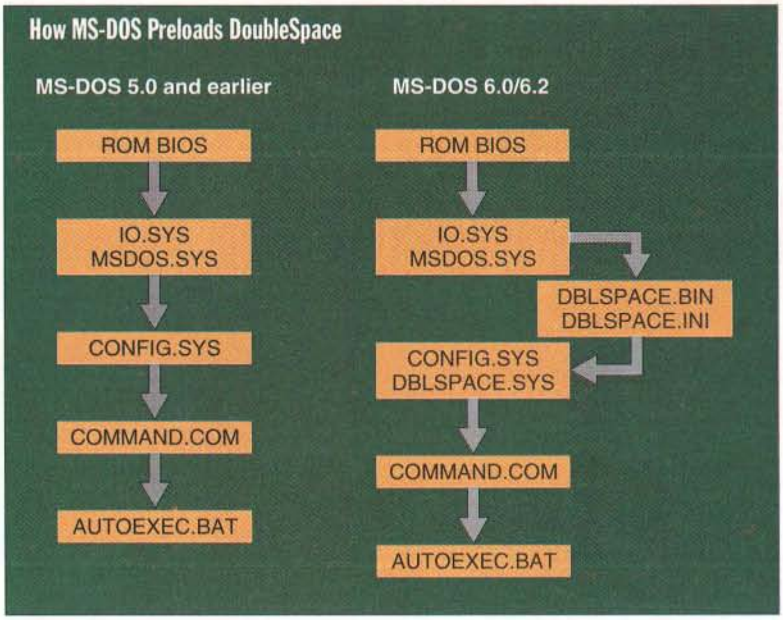

Before the release of version 6.0, *MS-DOS loaded all device drivers from CONFIG.SYS. But DOS 6.0 has a modified IO.SYS file that automatically loads a device driver called DBLSPACE.BIN, which, in turn, calls a new configuration file named DBLSPACE.INI. Only then does CONFIG.SYS execute, loading any other device drivers, as well as a short program called DBLSPACE.SYS that relocates the DoubleSpace driver into upper memory. Stacker 3.1 is the only other real-time disk compressor that preloads in this fashion under MS-DOS.*

Bracketed numbers represent pointers and tokens, so [9,4] tells DoubleSpace to replace the pointer (9) and token (4) with the four-character pattern that begins nine characters before the pointer.

The result: The compressed version requires 37 bytes instead of 44. That's not an enormous saving, but the method works much better on database files, whose fields are padded with lots of spaces, and on graphics files that have large areas of solid color. (The algorithm does not care whether the patterns of bytes represent ASCII characters or any other kind of data.)

This method is known as sliding dictionary because the compressed data itself contains the "dictionary" of patterns that's later used to reconstruct the file and because the compressor works its way through the file using a fixed-size sliding window. In other words, the compressor will not scan backward through the entire file to locate a matching pattern; it searches only a window of bytes that slides through the file during compression. The size of that window usually ranges from 2 to 8 KB. (DoubleSpace's sliding window is about 4 KB.)

These and other variables allow for some product differentiation, but in truth, no lossless disk compressor enjoys a knockout advantage in terms of compression efficiency or speed. Much more important is how the compression software interfaces with the operating system, how the compressed volumes are structured, and the quality of their diagnostic and repair utilities.

Implementing Compression

To keep data compression as transparent as possible to the user (and to applications), it's best implemented as a background process that hooks into the normal file system and automatically compresses and decompresses files as they're saved on disk. If the compression software installs itself as a virtual drive on the system (similar to a logical partition), it can recede even further into the background. On PCs, however, that requires finding room in memory for yet another device driver and then protecting it from other drivers, rogue programs, and territorial TSRs.

File-level compressors (e.g., PKZip) don't test the fragility of the DOS environment because they don't run in the background, and their compressed files don't appear any different to the system than do ordinary files. But real-time compressors must rely on a device driver to reroute all file I/O through their compression routines.

Before MS-DOS 6.0, most third-party compressors used the same method employed for years by RAM disks, which are also virtual drives: They loaded the device driver from the CONFIG.SYS file during bootup. However, this approach has a few disadvantages. To swap drive letters so that the compressed drive appears as drive C, both the virtual drive and the physical drive need duplicate copies of CONFIG.SYS, AUTOEXEC.BAT, and all files they reference. This, in turn, leads to synchronization problems when you make any changes to the files.

Another potential problem is the competition for memory. If too many device drivers and TSRs load into conventional memory (i.e., the first 640 KB of RAM), some MS-DOS programs—particularly games—will not have enough memory to run. If you modify the CONFIG.SYS file to load the compressed drive's device driver into upper memory (i.e., the area above 640 KB and below 1024 KB), it may conflict with other device drivers or TSRs competing for the same territory.

Preloaded Drivers

Digital Research's DR-DOS 6.0 offered a novel solution: A new system file called DCONFIG.SYS that booted before CONFIG.SYS. SuperStor's device driver could load from DCONFIG.SYS immediately after the memory manager, mount the compressed drive, and then chain to CONFIG.SYS on the compressed drive before any other TSRs or drivers tried to grab memory. In other words, the compression software got a head start.

With the release of MS-DOS 6.0, Microsoft achieved basically the same result with a somewhat different approach. Previous versions of MS-DOS couldn't load a device driver before CONFIG.SYS, but MS-DOS 6 has a modified IO.SYS boot file that automatically preloads a device driver called DBLSPACE.BIN before CONFIG.SYS executes.

DBLSPACE.BIN reads a new configuration file called DBLSPACE.INI, mounts any compressed drives it finds listed there, assigns the appropriate drive letters, and only then passes control to CONFIG.SYS. This happens before any other device drivers or TSRs get a chance to load from CONFIG.SYS or AUTOEXEC.BAT. The CONFIG.SYS file still needs to run a program called DBLSPACE.SYS that relocates DBLSPACE.BIN from conventional memory to upper memory. Even if DBLSPACE.SYS doesn't run, or if the entire CONFIG.SYS file is trashed, DBLSPACE.BIN still preloads and mounts the DoubleSpace drive.

Once the compressed drive is mounted, it appears to the system as a virtual drive. All file I/O happens normally, except the device driver intercepts the I/O to compress and decompress files as they're saved and loaded from the new drive.

Besides DoubleSpace, Stacker 3.1 is the only other compressed-drive product for MS-DOS that preloads its driver before CONFIG.SYS. Earlier versions of Stacker used the former method of loading the device driver within CONFIG.SYS. SuperStor and Vertisoft System's DoubleDisk Gold still load their drivers from

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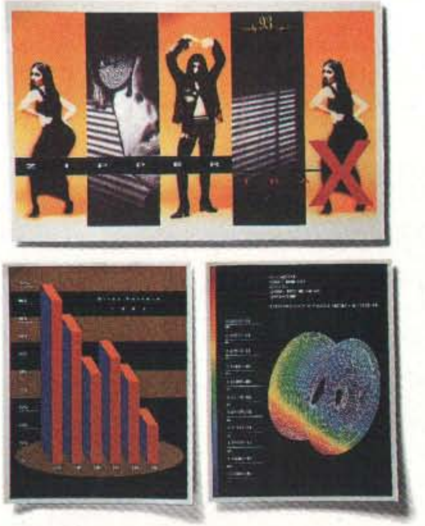

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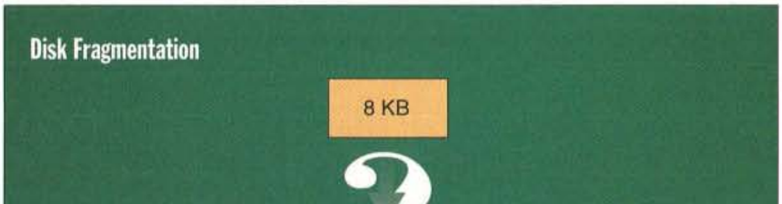
CONFIG.SYS when running under DOS.

However, SuperStor/DS—a new DoubleSpace-compatible version of SuperStor included with IBM's PC-DOS 6.1 (which will soon be the only version of SuperStor available)—preloads its driver before CONFIG.SYS when running under IBM's PC-DOS 6.1, which has the same preload capability as MS-DOS 6.0. And the latest version of DR-DOS—now called Novell DOS 7 after Novell's acquisition of Digital Research—comes with Stacker 3.1 instead of SuperStor and also adopts the preload technology.

IIT's XtraDrive adds still another twist. Although XtraDrive loads a device driver from CONFIG.SYS like SuperStor and DoubleDisk Gold, it handles file I/O a bit differently. When you install XtraDrive on a hard disk, it relocates the DOS boot files elsewhere on the drive and substitutes its own custom boot files in the boot sector. As a result, XtraDrive boots first when you switch on the machine, and DOS boots immediately afterward. That allows XtraDrive to intercept calls to BIOS INT 13 (disk I/O) and redirect the I/O to its own compression routines.

Because XtraDrive still relies on CONFIG.SYS to load its device driver, it is as vulnerable as SuperStor and DoubleDisk Gold to CONFIG.SYS problems. If the critical command in CONFIG.SYS is accidentally deleted or the CONFIG.SYS file is trashed or the device driver is somehow corrupted, the compressed drive won't mount. Users have not lost any data at that point, but they will probably be alarmed that their compressed drive seems to have vanished.

The compressed drive is still there, of course, but it's not recognized by DOS until the problem is corrected. In a worst-case scenario, an unsuspecting user might panic and do something that actually destroys the data (e.g., assume the data is already lost, reformat the hard disk, and reinstall the compression software). For these reasons, the ability to preload a device driver independently of CONFIG.SYS is considered an important safety feature of real-time disk compressors.


Disk Fragmentation
8 KB
Variable-size compressed clusters
16-KB total free space, noncontiguous

When a compressed drive *becomes badly fragmented, it may cause puzzling disk-full errors, even when there is enough free space to store the file. This happens when a piece of data won't fit into any of the free but noncontiguous variable-size clusters. In this case, an 8-KB chunk of uncompressible data can't be saved on the drive, even though there's 16 KB of space available. The PC version of Stacker can avoid this dilemma by subdividing the cluster and storing the pieces in noncontiguous locations.*

Data Integrity

Other safety factors come into play after the device driver loads into memory, and DOS mounts the compressed drive. Compression products take significantly different approaches in the way they simulate a virtual drive and organize their internal structures.

For example, DoubleSpace, Stacker, SuperStor, and DoubleDisk Gold all simulate a virtual drive by creating a single, large file on the uncompressed host drive. (Microsoft calls it a compressed volume file, or CVF.) In other words, the hundreds of files stored on your compressed drive actually appear on the physical drive as a single file.

It is not just an enormous jumble of data, of course—the file mapping is handled internally by the compression software. (XtraDrive, again, is the exception; it stores compressed files in the normal fashion.)

Some people fear that storing everything in one massive file compromises data integrity. However, a number of safeguards and cross-checks are built into the compression architectures to prevent you from losing information even if the CVF is corrupted. What's most important is not whether compressed data is stored in a CVF or in discrete files, but rather the integrity of the compression architecture and how readily you can diagnose and repair common problems with disk utilities.

This is the main battleground on which compression vendors are waging warfare. It also accounts for much of the controversy over DoubleSpace.

Cluster Bombs

For instance, a significant difference among DoubleSpace, SuperStor, DoubleDisk Gold, and Stacker 3.1 is how they store compressed data. All handle data in 8-KB chunks that are compressed to fit variable-size clusters. A cluster may contain 1 to 16 sectors, each 512 bytes long. But only Stacker can subdivide a cluster and store the pieces in scattered locations on the disk. The others must store a cluster in sectors that are contiguous.

This can lead to problems if the compressed drive becomes badly fragmented. Fragmentation inevitably happens over time as you save, delete, and resave files on a disk. It happens faster under certain conditions, but gradually all disks become fragmented, especially if they're nearly full. Eventually, there's not enough contiguous free space to save an entire file, so DOS has to split up the file and store the clusters in various places around the disk.

Other than slowing down disk I/O, fragmentation isn't a serious problem on an uncompressed drive, because the clusters are always a fixed size. As long as DOS can find enough free clusters, no matter where they're located, it can save the file. If there aren't enough free clusters, DOS returns a disk-full error.

On a compressed drive, however, things are a little more complicated. (Well, a lot more complicated.) To begin with, the actual size of a cluster varies in direct proportion to the compression ratio. The goal is to more efficiently use the disk space that DOS often wastes.

Because uncompressed DOS disks have fixed-size clusters (usually 8 KB), a tiny five-line batch file would still occupy a whole cluster. On a compressed drive, that file could be stored in a one-sector cluster (512 bytes), thus saving 7.5 KB of disk space. If you save an 8-KB file on a compressed drive and if the compressor achieves a 2-to-1 compression ratio, the resulting file needs only 4 KB and occupies a cluster of eight sectors (8 times 512 bytes equals 4 KB). The best possible case is a 16-to-1 compression ratio (yielding a one-sector cluster, 512 bytes). The worst case is a 1-to-1 ratio—no compression (yielding a 16-

Achieving the impossible.

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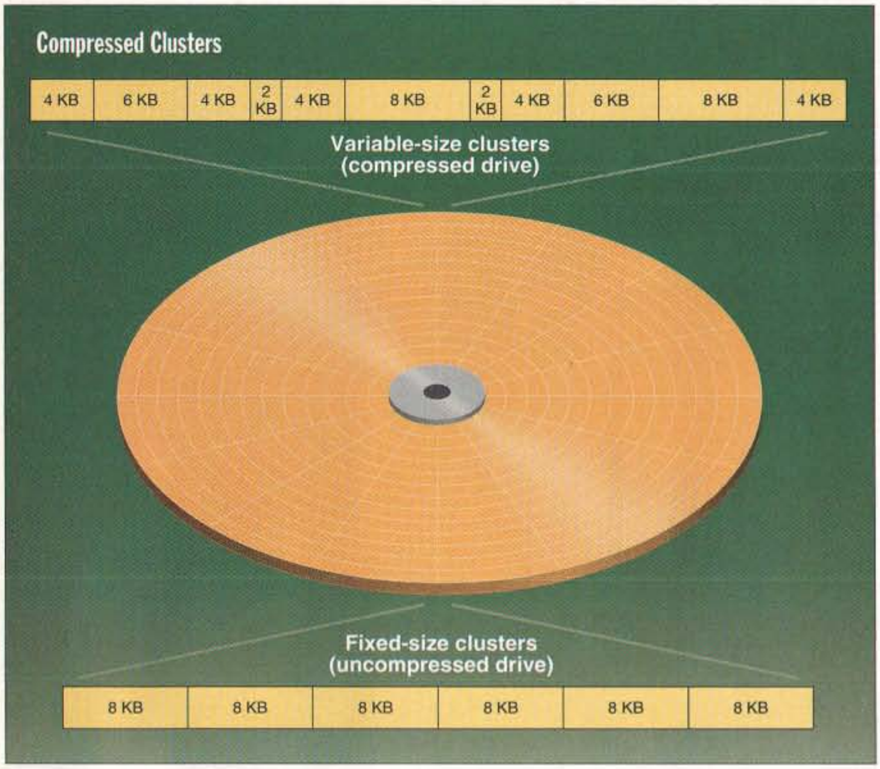

Uncompressed DOS drives *normally store data in fixed-size clusters of 8 KB. (Macintosh clusters are also fixed size, but the size varies depending on the drive capacity.) Compressed drives store data in clusters that vary in size according to the compression ratio. A cluster may be as small as 512 bytes (assuming a 16-to-1 compression ratio) or as large as 8 KB (if the data is uncompressed). The average is about 4 KB (2-to-1 compression).*

sector cluster, 8 KB).

OK, so far. But what if the compressed drive is badly fragmented and DOS can't find enough contiguous sectors to store a cluster? Stacker 3.1 will break up the cluster into smaller pieces (known as *extents*) and fill in the holes. DoubleSpace, SuperStor, and DoubleDisk Gold can't do this. Instead, they return a disk-full error—even if there's actually enough free space on disk to save the file.

The problem gets worse if you're trying to save data that can't be compressed. Perhaps the file is encrypted or has already been compressed with PKZip or is being downloaded as a GIF (CompuServe's compressed file format for graphics). The 8-KB cluster can't be compressed any further, so it needs 16 contiguous sectors (16 times 512 bytes equals 8 KB). Even if the compressed drive has megabytes to spare, DoubleSpace, SuperStor, and DoubleDisk Gold can't save the file if they can't find 8 KB of contiguous free sectors.

In theory, the compressed drive could have hundreds of megabytes free and still return a disk-full error because of a single cluster that won't fit in the holes. In reality, could a drive actually become that severely fragmented? Not likely, in normal use. But Blossom Software (Cambridge, MA), which sells a diagnostic utility called DoubleCheck, gives away a small program called Bust that demonstrates the problem.

Bust deliberately fragments a DoubleSpace drive and then attempts to save a file that won't fit within the clusters. (Don't try this on a drive with important data.) According to Alan Feuer, director of software development at Blossom, DOS 6 sometimes won't return a disk-full error but, instead, reports that the file was successfully saved. Result: a trashed file. Feuer says Microsoft fixed the problem in DOS 6.2.

Microsoft denies such a bug exists, but those who are curious can find Bust in the IBM Forum on CompuServe. (Microsoft removed it from the MSDOS Forum.)

Of course, you can avoid all these problems by defragmenting the compressed drive (e.g., using either DOS's DEFRAG or a third-party utility) on a regular basis; however, some users are not very attentive to system maintenance. What they need is some kind of background defragging that functions as transparently as background compression. AddStor sells a product called DoubleTools for DoubleSpace that—among other things—provides this important function.

FAT Structures

Stacker drives get fragmented just as easily as other compressed drives, but since they can subdivide clusters, there's less chance you'll encounter a mysterious disk-full error. The PC version of Stacker (but not the Macintosh version) can do this because it has an additional mapping table that keeps track of the scattered extents. The extra table is an extension of the FAT (file allocation table), which DOS uses to allocate clusters.

Here's yet another area where compression products differ. They each take a slightly different approach to how they organize and verify the integrity of the FAT and related mapping structures. Naturally, each vendor claims its approach is the most reliable.

If a disk's FAT gets corrupted, DOS won't know which clusters of data belong to which files. If you can't repair the damage, the result could be lost data. For safety, therefore, DOS normally keeps two copies of the FAT on an uncompressed disk. Stacker and XtraDrive also keep two FATs on their compressed disks. DoubleSpace, SuperStor, and DoubleDisk Gold keep only one FAT.

The argument for keeping two FATs is redundancy: If one FAT gets trashed, a repair utility can try to restore it with information from the second FAT. The argument for keeping one FAT is simplicity: If two FATs somehow get out of synchronization, which one is correct?

This could happen if your computer crashes or the power fails while saving a file on a compressed drive. The disk I/O might be interrupted after DOS has updated only one copy of the FAT. It's even more likely if you're using writeback disk caching, because the FAT update could be delayed a few seconds. (One of the changes between MS-DOS 6.0 and 6.2 is that SmartDrive's writeback caching is now turned off by default.)

Microsoft contends that not only are two FATs unnecessary, but that the extra mapping table Stacker uses to subdivide clusters adds yet another layer of complexity to an already complex scheme. In fact, compressed drives from all vendors have internal mapping structures that are much more complex than ordinary drives because they have to keep track of such things as variable-size clusters and compression ratios. DoubleSpace, for example, supplements the normal FAT with a BitFAT and an MDFAT. Stacker's mapping table for extents adds a third level of indirection beyond the FAT and the variable-size cluster mapping.

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PC DISK-COMPRESSION SOFTWARE COMPARISON

PRODUCT	PRELOADED DRIVER[1]	COMPRESSED VOLUME FILE[2]	DIVISIBLE CLUSTERS[3]	COMPRESSED FATS[4]
Vertisoft DoubleDisk Gold	No	Yes	No	1
Microsoft DoubleSpace	Yes	Yes	No	1
Stac Electronics Stacker	Yes	Yes	Yes	2
AddStor SuperStor DS	Yes[5]	Yes	No	1
AddStor SuperStor Pro	No	Yes	No	1
IIT XtraDrive	No	No	No	2

[1] The device driver for the compressed drive loads during bootup before CONFIG.SYS

[2] The compressed virtual drive appears on uncompressed host drive as a large, single file

[3] Compression software can subdivide a cluster to store data in noncontiguous sectors

[4] Number of file allocation tables on the compressed drive

[5] PC-DOS 6.1 only

W. Slivka, development leader for MS-DOS. Slivka says third-party tool vendors complain that Stacker's architecture is more difficult to support. While true, that hasn't stopped the tool vendors. Most of the major diagnostic and repair utilities support both DoubleSpace and Stacker, although there's less support for SuperStor, DoubleDisk Gold, and XtraDrive, which don't command as much market share.

All disk compressors also come with their own utilities, and these tools are tailored for their unique compression architectures. Often, they try to turn complexity into an advantage by performing extensive cross-checks between the various mapping structures. XtraDrive, for example, compares both copies of the compressed drive's FAT during bootup. If they don't match, the user is advised to run a program called VMU (Volume Maintenance Utility). VMU tries to figure out which FAT is correct by checking file links, mapping tables, and free clusters.

Strange Interactions

Anytime something as complex as real-time disk compression is introduced into an environment as unruly as DOS, there are bound to be unforeseen consequences. When a mysterious problem can be traced at all, often it's not directly caused by the compression software itself, but rather by interactions among various elements of the system (see the text box "Data Loss: A Cautionary Tale" on page 64).

Microsoft has compiled a list of software that may not work on a DoubleSpace drive, including protected copies of Lotus 1-2-3 release 2.01, Informix relational database, MultiMate 3.3/4.0, the DOS version of Quicken, Movie Master 4.0, Tony La Russa Baseball II, Empire Deluxe, Links, Ultima, and others. Some of these programs won't run on any compressed drive, and the reasons vary widely, ranging from tricky copy-protection schemes to their handling of temporary files.

Different versions of the ROM BIOS are known to cause problems, too. Some BIOS chip sets don't properly handle an interrupt call made by DBLSPACE.BIN during bootup, resulting in stack corruption. The DOS 6.2 version of DBLSPACE.BIN doesn't call this interrupt.

Writeback disk caching has also been singled out for blame. Some users are in the habit of switching off their computers immediately after quitting an application or even without quitting. If the disk cache isn't flushed before the power goes down, open files may not be closed properly, and the FAT may not be updated. It's a small problem that can snowball, eventually corrupting multiple files. DOS 6.2 now makes sure the cache is flushed before redisplaying the DOS prompt on the screen, but what DOS really needs is a controlled shutdown procedure like that of Windows NT, Unix, and the Mac.

Another interaction is possible with the MS-DOS FORMAT command. Many users scan their hard disks with utilities that check the media for surface errors and then mark those bad sectors so that they'll never be allocated to files. The bad sectors are deallocated in the FAT. But what most people don't know is that FORMAT rewrites the FAT and may reset the bad-sector flags, thus freeing those sectors for allocation to files.

This little detail stumped some users who backed up and reformatted their hard drives before installing MS-DOS 6 and DoubleSpace. Their idea was to clean off the disk and reduce the considerable amount of time it can take to compress a crowded drive. Ironically, it's the kind of thing only a power user would think of; it probably wouldn't occur to a casual user.

But if they didn't immediately follow the reformat with another disk scan, there's a chance at least one file would end up in a sector previously marked as bad. Sometimes that file happened to be the DoubleSpace CVF. And what happened next depended on the kind of data stored in that sector. If it was part of an executable file, the program would probably crash. If it was part of a data file, information could be lost. Either way, the hapless user was in the dark.

Why wasn't this problem discovered before MS-DOS 6 and DoubleSpace? After all, the FORMAT command has worked the same for years. But apparently, it wasn't noticed or considered important until data compression made the environment more precarious.

Fortunately, Microsoft says it has changed the FORMAT command in DOS 6.2 so it doesn't reallocate bad sectors marked in the FAT. Also, a new utility in DOS 6.2 (ScanDisk) automatically checks the drive for bad sectors before installing DoubleSpace.

Only a tiny minority of users would be affected by something like this, but that's potentially a lot of people when multiplied across the huge installed base of MS-DOS. In fact, MS-DOS 6.0 and DoubleSpace have inspired a whole cottage industry of diagnostic programs, fix-it tools, and free advice on public networks.

Touchstone Software (Huntington Beach, CA), which sells a disk utility called CheckIt Pro, inadvertently upset Microsoft by posting a free program on CompuServe last summer that scans a hard disk for bad sectors. Touchstone was among the first to identify the FORMAT problem. Company president Shannon Jenkins says her small company got in hot water with Microsoft, but she added, "I think the release of DOS 6.2 has borne us out…the things we talked about back in June have now shown up in DOS 6.2."

Microsoft was the first company to encourage users to install data compression without taking security measures. "Just press Return, and you'll get data compression and writeback caching and lots of other stuff," says Jenkins. "Microsoft should have encouraged users to take a more cautious approach."

Hardware Compression: Full Circle?

Microsoft has a golden opportunity to clean house with the upcoming release of Windows 4.0 (code-named *Chicago*). As a major revamping of the PC environment, Windows 4.0 could sweep away years of old code and build a new foundation that's designed from the ground up to accommodate such features as data compression.

However, there's another possibility: By submerging compression even deeper

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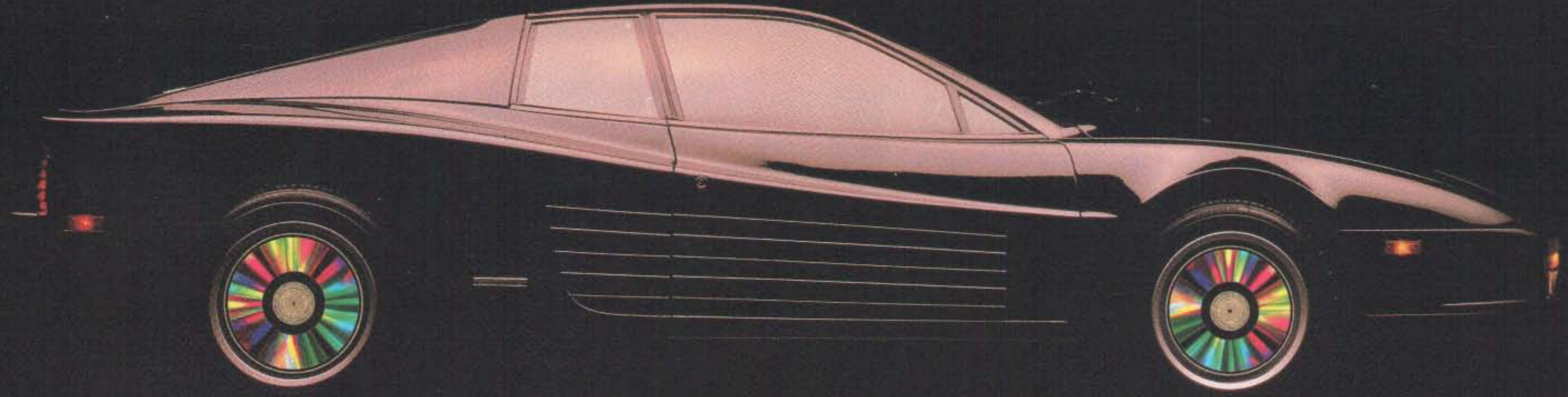

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than the operating system, it could be made even more transparent and foolproof. What's deeper than the operating system? The hardware.

Once again, hardware-based data compression is an old idea. Back in the days when 8086- and 286-based PCs were the norm, there was a market for plug-in ISA boards that sat on the I/O bus, compressing and decompressing data on its way to and from the hard drive. The compression algorithms were hard-wired into high-speed chips. Real-time compression couldn't be done in software back then because CPUs weren't fast enough. Not until speedy 386 microprocessors became available could software-based compressors work in real time without noticeably affecting system performance. And the plug-in boards became obsolete because they were constrained by the slow speed of the ISA bus.

Hardware-based compression still survives in tape backup units, where it's so reliable and transparent that users scarcely know it's there. In fact, the widespread QIC (quarter-inch cartridge) compression standard for tape backup originated at Stac in the mid-1980s.

Now Stac and other companies are taking another look at hardware compression. The potential advantages are many: Better integration with the system; more transparency to users; greater compression ratios; improved system performance; and, perhaps, faster networking.

Speedy local buses such as VL-Bus and PCI (Peripheral Component Interconnect) are appearing in more new PCs, thus solving the ISA constraint. Hardware compression would require little or no installation or intervention by the user. Greater compression ratios are possible because high-speed compression chips can use more complex algorithms. They also free the CPU for other tasks and don't occupy memory, as software-based compressors do. Finally, by keeping the data compressed as it moves through the computer and over networks, hardware-based solutions can dramatically improve overall system performance.

The Future of Compression

What kinds of performance gains are possible? Stac says it already has a prototype VL-Bus card that compresses data 20 percent to 50 percent faster than software-based compressors and uncompresses 10 percent to 30 percent faster. But that's just a start.

Software compressors currently work at about 1 MBps on a 66-MHz 486, and about 2 MBps on a Pentium. By next year, Stac says it will have compression chips capable of 10 to 20 MBps; in two or three years, 50 to 60 MBps. Of course, CPUs will get faster, too, but not anywhere near that pace.

Safety Tips for Disk Compression

- **If you're using MS-DOS 6.0, you should upgrade to 6.2.**
- **Before installing compression, prepare your hard disk by cleaning off all unwanted files and then running a defragmenter and a thorough surface test. (This may take a few hours.)**
- **Back up the hard disk, just in case.**
- **Read the installation instructions carefully, especially any warnings about disabling incompatible TSRs or other programs.**
- **After installing compression, be conscientious about system maintenance. Regularly run a defragger and any diagnostic utilities that came with the product.**
- **Consider buying a good third-party diagnostic/repair utility to supplement the standard utilities.**
- **Try to avoid completely filling the compressed drive.**
- **Avoid saving encrypted files or files that are already compressed (e.g., ZIP, ARC, and GIF) on the compressed drive. They can't be compressed any further, and they'll load faster from an uncompressed drive.**
- **Hard disk space currently costs about a dollar per megabyte; if you can afford to upgrade and your system has room to expand, it's still the best solution.**

The compression chips could be built right onto the motherboard and would add about $100 to the street price of a computer, according to Stac. They'll probably show up first in high-end systems.

Last year, Stac made a deal with Novell to license the Stacker compression technology for use in Novell DOS 7 and all networking software. "Stac's vision is that data should need to be compressed only once," says John Bromhead, Stac's vice president for marketing. "After it's compressed, it should stay compressed whether it's transferred to disk or tape or across a network or through the system or whatever."

That's also IBM's vision. IBM Microelectronics is introducing a series of compression chips that couple directly to the CPU. According to Ted Lattrell, development manager, the first chip already compresses data at 40 MBps, and future versions could hit 100 MBps. Lattrell says the chips have already attracted interest from PC and workstation vendors, who are planning to introduce systems later this year or in early 1995.

"Once it happens—once compression is hard-wired into the first system—there's no going back," says Lattrell. "A system without built-in compression would be at a disadvantage in the marketplace. I think hardware compression will alter the way data is represented inside computers for years to come."

Indeed, IBM is researching the possibility of putting ultraspeed compression chips on the CPU's memory bus. That would do for RAM what disk compressors do for hard drives—effectively double the computer's main memory.

Beyond that, it's possible that compression chips will eventually be integrated within the CPU itself, just as math coprocessors migrated to CPUs on the 486DX and 68040. Today's 0.8-micron process technology makes about 625,000 gates available on a chip, and IBM's compression engine requires only 75,000 gates. Soon, 0.5-micron processes will enable about 1.3 million gates, and IBM hopes to shrink the compression engine down to only 40,000 gates. That makes built-in compression a real possibility for high-end microprocessors, such as the PowerPC 620 under development by IBM, Motorola, and Apple.

One drawback to hardware compression is that it creates a problem when you transfer files over a network or by removable disks to systems that don't have the same compression hardware. A similar problem exists with software compression, and it's usually solved by including a decompression driver with the file or the media.

A more important consideration is that hardware compression, although an old idea, will nevertheless be as new to most of today's users as software compression was before DoubleSpace.

"When you stick this hardware compression into the system, people are going to wonder how it affects their software-based compression," says Phil Devin, vice president of storage technologies for Dataquest (San Jose, CA). "Do their compressed files get compressed again? Is there a conflict? Here comes one more level of uncertainty that's going to be an inhibiting factor at first."

Devin recently wrote a newsletter debunking the idea that data compression of any kind is a free lunch—an idea that particularly caught hold when Microsoft started bundling DoubleSpace with DOS 6. "It's not something for nothing," he says. "It's something that takes work." ■

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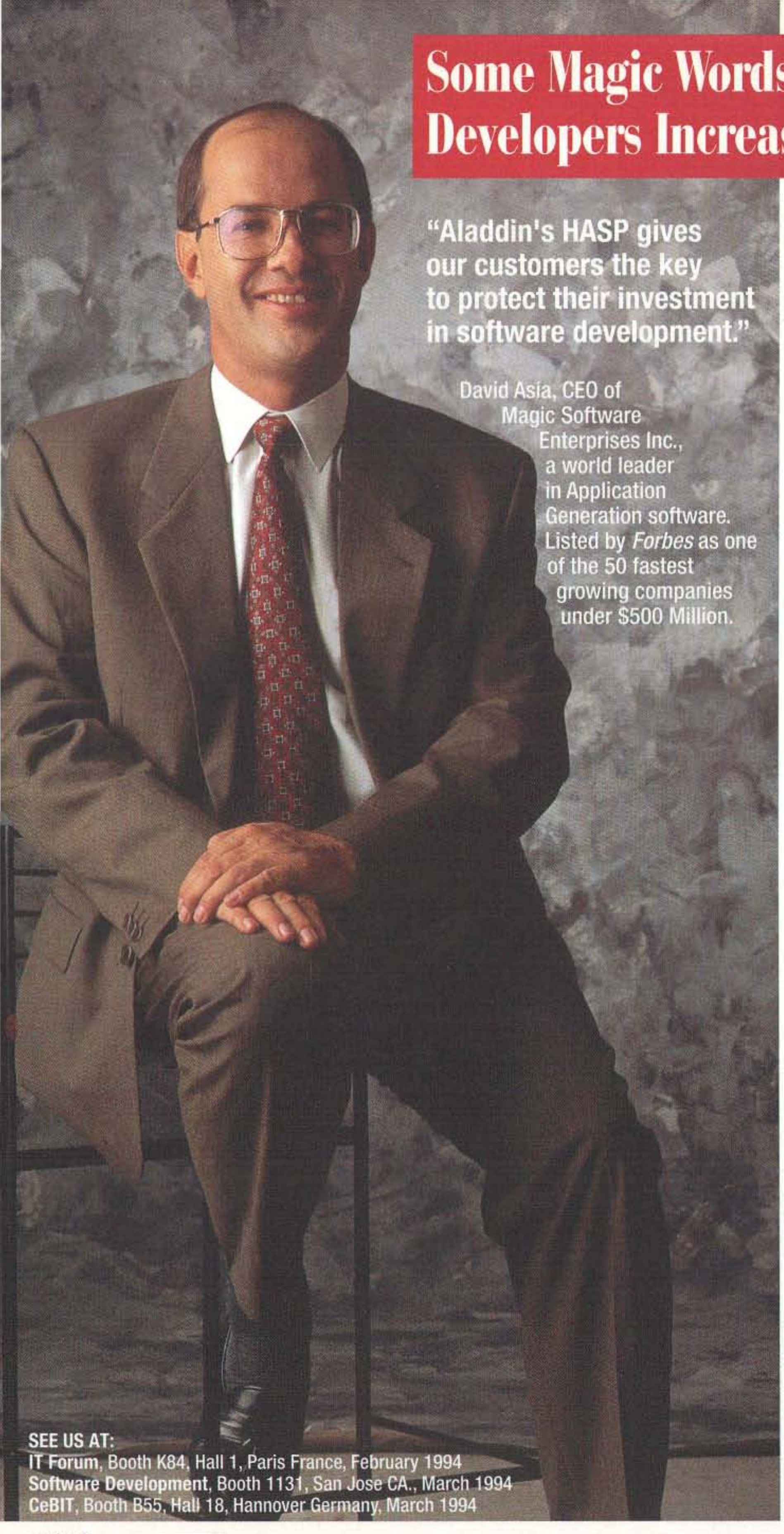

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State of the Art

TODAY'S COMPILERS

It's a brave new world for compiler makers. New CPUs, new operating systems, and demands for programmer productivity call for compilers that produce faster code—and produce code faster.

FRANK HAYES

A few years ago, compilers seemed simple enough. Steadily improving optimization techniques meant that each year's compilers would generate code just a little bit faster than last year's models. Most companies making compilers, and most programmers using them, focused on a single computing platform—PCs, Macs, Unix workstations, or IBM mainframes. And to a large degree, a compiler was just a compiler.

Those days are now gone. New CPUs including the Intel Pentium, the IBM/Apple/Motorola PowerPC, and the DEC Alpha are suddenly major targets for software development. Software developers now need easier ways to write for DOS, Windows, Mac, OS/2, Windows NT, Unix, and other operating systems—if possible, all at the same time.

And the compiler is now just one part of a complete development environment designed to help create clean, fast code. "Managing the sheer complexity of the development process is a big problem," says Michael Hyman, business unit manager for languages at Borland International. Management today must coordinate the efforts of multiple, large, perhaps geographically dispersed project teams, when one group may be working on a feature upgrade and another doing a cross-platform port of the same application. Code testing, source code control, and limitations of development tools must be addressed head-on.

Compiler vendors say they're up to the challenge. They have sophisticated products today and even more complex plans for the future, all aimed at improving programmer productivity on an ever-widening selection of platforms. In the world of software development, programming demands are becoming more complicated and programming schedules shorter. Programmers need all the help they can get.

Shock Wave

The biggest shock for most programmers is the sudden requirement that they support a wave of new processors. For nearly a decade, two CPUs dominated mass-market software: the Intel 80x86 family for the PC and the Motorola 680x0 for the Mac. Expert programmers could fine-tune code at the assembler level to optimize code.

No more. Apple's next generation of Macs will use the IBM/Apple/Motorola PowerPC CPU, but Apple will still offer 680x0-based Macs. Microsoft has already provided its NT operating system with compiler support for the Alpha and Silicon Graphics' Mips R4000 CPUs. NT is also reportedly being ported to other processors, including SPARC (by Intergraph) and PowerPC (by Motorola).

It's not just the CPU population that's exploding, either. Where once DOS, Windows, and the Mac reigned supreme, there is currently a dizzying array of systems to write to, including OS/2, NextStep, Win16, Win32s, Win32c, a more unified Unix, and forthcoming systems such as Taligent and IBM's Workplace OS. Most developers will eventually need to support them all.

Personality emulators that run off-the-shelf software handle only part of this new multiplatform requirement. Most new applications will have to be recompiled for several different platforms. The choice of tools and procedures is critical, for it may be necessary to provide capabilities that are not native to the target platform.

Major compiler makers have already leaped to fill the cross-platform gap—each with a different strategy. For example, Microsoft no longer supports OS/2 with its compilers. But Microsoft fully supports Windows on multiple CPUs, and it plans to support Mac development from the same code base on both 680x0 and PowerPC-based Macs, starting sometime this year.

In contrast, Borland supports OS/2, DOS, and several varieties of Windows—but only on 80x86-based PCs. However, Borland also claims better compliance with industry language standards. Its C++ development system includes class libraries from Rogue Wave Software that allow much easier porting of code to Unix workstations.

Symantec supports PC and Mac development with separate compiler products, although the company claims that both products use its common-core compiler technology, which makes porting easier. Symantec licenses class libraries from Microsoft and is Apple's official partner in creating compilers for the PowerPC Macs.

Watcom International supports DOS, OS/2, and 80x86-based Windows platforms, as well as NLMs (NetWare loadable modules) for Novell networks. Other vendors, such as MetaWare and Liant, span the PC and Unix worlds. And even Unix-only compiler makers (e.g., SunPro) are targeting SPARC, 80x86, and PowerPCs (see "Developing for Multiple Platforms" on page 91).

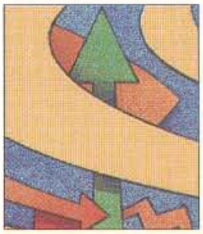
To C or Not to C

To support such a wide range of platforms, C++ has emerged as the programming language of choice. "C++ brings the benefits of OOP together with the power and flexibility of C, which gives you explicit control over what the machine's doing," explains Dave Boswell, vice president of marketing and sales at Watcom.

Although C++ supports C programming constructs, it is decidedly a different language that requires its own techniques and supporting tools. But C++'s object-oriented nature, along with its ability to use class libraries that simplify portability to different CPUs and operating systems, put it at the center of the compiler strategies of Microsoft, Borland, and other vendors.

Still, C++ isn't alone as a development

Today's Compilers
Compilers have to support new CPUs and operating systems 76



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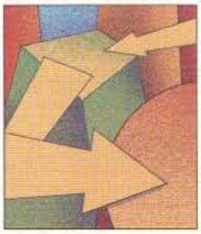

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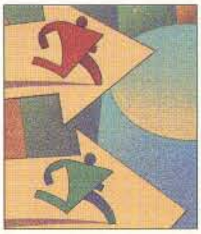

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language. FORTRAN is still in demand for scientific applications. Ada, after nearly a decade of development in primarily military environments, has come into its own for applications requiring high reliability and code reuse. And older languages such as Pascal and especially COBOL are still in wide use. Indeed, COBOL remains the most widely used programming language for mainframe and other transaction-oriented business applications.

To meet the demand for multiple languages, compiler vendors increasingly use the same core compiler for several languages. Even fully integrated compilers first parse the source code into an internal code that can then be used to generate optimized code for the target platform. By changing only the source code parser, compiler vendors can get several compiler products from a single code-generating "back end." For programmers, a common back end means it's easier to combine modules written in different programming languages into a single final application.

The Productivity Challenge

There's also a renewed demand for faster development. ISVs (independent software vendors) and programmers in corporate MIS departments are under increasing pressure to turn out better programs faster.

For ISVs, the issue is simple competition. Time-to-market and software quality have become crucial; a few months' delay or serious flaws in a product can cost a major vendor millions of dollars in sales—or even its existence. One-time software giants (e.g., Ashton-Tate, whose dBase IV was first delayed and then buggy) are testimony to what can happen when software products are late or less than perfect.

Corporate MIS departments face different business demands, but the goal is the same: They, too, need to complete applications faster and without bugs to gain an edge over the competition. Although the newest compilers often come with tools for generating GUIs, many corporate developers are opting for 4GLs (fourth-generation languages) and other rapid, high-level applications development tools for simple applications. In many cases, corporate developers may use traditional compilers only for their most demanding projects.

For Professionals Only

Because of the challenges of graphical environments and multiple platforms, professional developers—not casual or occasional programmers—are the chief market for top-flight development tools. As a result, both compilers and the tools programmers use with them are more sophisticated.

The goal is improved productivity. One solution will always be faster compilers that produce reliable, efficient code. Delivering this requires ever more sophisticated optimization and scheduling strategies. Another emerging key to programmer productivity is improved links between the compiler and other development tools, including debuggers, profilers, browsers, and even editors. "The days are gone when people would just buy stand-alone command-line compilers," says Gene Wang, executive vice president for applications and development tools at Symantec.

Development tools generate information about the code they process. Past tools were independent, unaware of one another, and they discarded much of the information they generated. As a result, compilers duplicated the work of syntax-checking editors and couldn't use the information that profilers and debuggers produced to optimize the code. Tools that continually re-created information about code cost programmers time—and productivity.

Today, sets of completely independent tools are rarer. Instead, an IDE (Integrated Development Environment) links compilers, editors, class browsers, and source-level debuggers. Borland, which popularized integrated development in the 1980s with Turbo Pascal, is still a leader, but Microsoft and Symantec have joined it with Visual C++ and Integrated Development and Debugging Environment, respectively, as have other compiler makers.

Tools that communicate with each other can dramatically reduce the time it takes to create and debug code. Once, such integrated tool sets would have been called CASE systems; today, they're just state-of-the-art compiler products. But there's still room for progress.

Compiler-generated information is routinely available to other tools, but the information produced by those tools is rarely available to the compiler. For example, compilers still cannot automatically use test results to further optimize code. That requires full-scale development databases that store everything from symbol tables to profile and test results, giving the compiler a wide range of information to improve optimization.

Putting It all Together

Improving programmer productivity is not just in the hands of programmers or compiler makers. Modern operating systems

MAJOR C++ COMPILERS

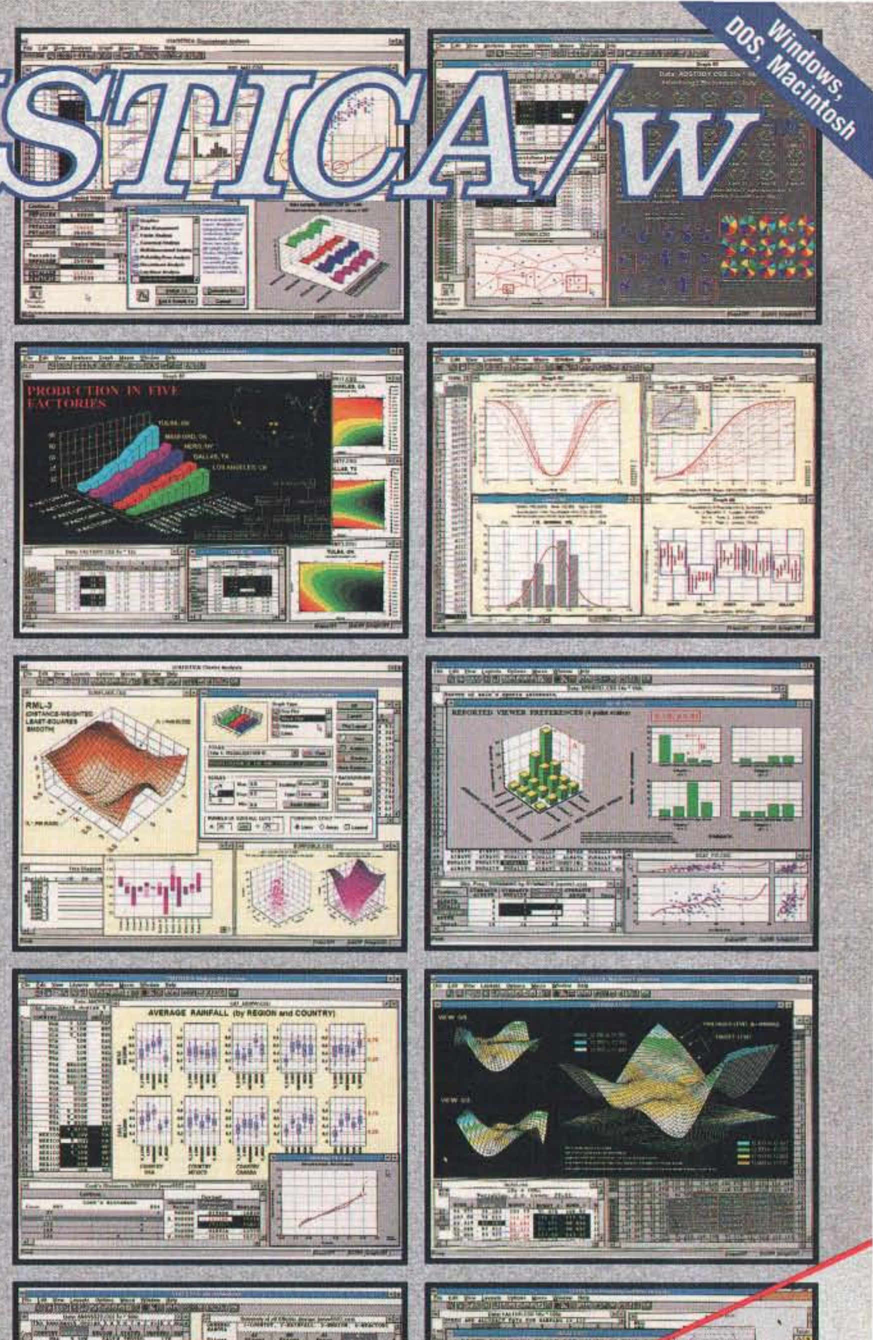
A roundup of C++ compilers used for desktop development.

VENDOR	COMPILER	CLASS LIBRARIES	DEVELOPMENT ENVIRONMENT	PLATFORMS SUPPORTED DOS	Windows	OS/2	Windows NT/Win32	Mac	PowerPC	NetWare NLM	Unix	SINGLE COMPILER/ SOURCE BASE?	NOTES
Borland International	**Borland C++, Turbo C++**	Object Windows Library	Integrated Development Environment	●	●	●	●	○	○	○	○	No	
Microsoft	**Visual C++**	Microsoft Foundation Class	Visual C++	●	●	○	●	🔵	🔵	○	○	Yes	Mac and PowerPC support based on MFC and Win32 libraries for the Mac
Symantec	**Symantec C++**	Microsoft Foundation Class	Integrated Development and Debugging Environment	●	●	○	●	●	🔵	○	🔴	No	Symantec and Apple to codevelop compilers for the PowerPC Mac
Watcom International	**C/C++-32**	Available but not included	Yes	●	●	●	●	○	○	●	○	Yes	Recently merged with Powersoft

● = supported ○ = not supported 🔵 = future 🔴 = some

Windows, DOS, Macintosh

STATISTICA/w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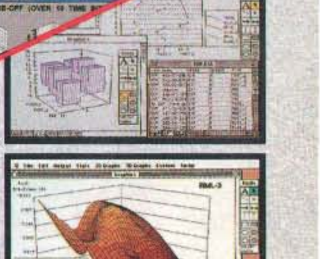

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are doing more for the programmer than ever before. Progressively more functionality is being built into operating systems like Unix, OS/2, and NT—not just GUIs but also networking, security, and object management.

Operating-system vendors estimate that anywhere from 50 percent to 90 percent of a typical application's time is spent within the operating system, rather than executing application-specific code. Of course, as programmers let the operating system do more of the work, there's less opportunity for the compiler to improve speed by optimizing raw code. But a sophisticated compiler can also optimize in terms of the operating-system programming interfaces.

Two programming approaches are helping to lift programmers' workloads. One is the use of class libraries—a step made possible by the popularity of C++. Class libraries such as MFC (Microsoft Foundation Class) and Borland's Object Windows Library are more than the object-oriented equivalent of function libraries. Instead, they insulate the programmer almost completely from the operating-system dependencies that make it difficult to port software from one platform to another. In fact, Microsoft plans to use the MFC libraries to let programs written for the Win32s programming interface be recompiled, without change, to run on the Mac.

The other approach that's helping programmers is the dynamic shared library—better known in the Windows environment as a DLL. In the past, when applications were compiled, all library function code had to be incorporated into the application. But in modern operating systems, ranging from Windows to Unix versions (e.g., Sun's Solaris), it's possible to call shared libraries instead. What's the advantage? Shared libraries can be upgraded independently. And since several applications may share the library, they're all improved at once—in theory. But one problem with shared libraries rears its head among Windows DLLs—the case where a DLL is "improved" in such a way that it benefits one particular application but can break other software that uses the DLL.

Class libraries, DLLs, integrated tool sets, and other features of the latest generation of compilers make them far more complex than past compilers—both for the vendors who make them and the programmers who use them. But strange as it sounds, these complex approaches actually make it easier, not harder, for programmers to do the things they need to do today. Thanks to the increasing sophistication of the available tools, the programmer can focus on what the application is supposed to do, leaving to the compiler the thorny issues of how to optimize the code and how to support an ever-growing variety of CPUs and operating systems.

Ironically, there's no end in sight to the sophistication of compilers. Vendors have just begun to support full-scale client/server applications and distributed objects. Tool sets are becoming more tightly integrated. And every year, compilers generate code that's *a lot* faster than the year before. ■

Frank Hayes is a former BYTE West Coast news editor and a contributing editor for the Client/Server ToolWatch *newsletter. You can reach him on the Internet or BIX at frankhayes@bix.com.*

Compiler Benchmarks: How Useful?

ALLEN I. HOLUB

Benchmarks offer an easy way to quantify compiler performance, making lots of spiffy tables. Unfortunately, those tables are often not the best way to evaluate a compiler's performance. Here are a few issues you should consider when looking at a benchmark-based compiler comparison.

Do run-time benchmarks say anything useful about a real application? For example, Dhrystone is a collection of small code fragments that exercise various language features. There's probably no relationship between the frequency of a fragment in the benchmark and the frequency of similar code in one of your programs.

A test that uses array indexing is not helpful if you use pointers. For a run-time benchmark to be meaningful, you'd have to do a statistical analysis of your own code and adjust the benchmark to match your coding style. A benchmark developed in this way will have no meaning when applied to a different coding style. The only way to really judge is to compile several real applications, not arbitrary benchmarks. Even then, compilers that perform better with some applications will perform worse with others.

Match the benchmark to the language. For C++ compilers, for example, test the efficiency of the in-lining process, the mechanisms that a binary-operator overload function uses for return statements, the way that virtual-function dispatching and virtual-base classes are handled. These concerns often outweigh the efficiency of a switch statement.

The range in efficiency of various compilers is usually insignificant when compared to the speed and size improvements that you can get by editing your code and reworking your algorithms. Most programs are 50 percent larger and 30 percent slower than necessary. Algorithmic changes (e.g., using a shell sort instead of a bubble sort) can improve performance by a factor of two or more. Even small code improvements (e.g., using pointers to go through arrays) can give you a measurable benefit.

Compile-time benchmarks are worthless. You're really interested in the development time of a large project over the complete development cycle. Time staring at the screen while the compiler works is indeed a factor, but so is the quality of the run-time library (a well-written library can save you months), the development environment, and the documentation (10 hours spent searching for critical information in badly written documentation is not offset by saving 2 or even 20 seconds in a compile). To evaluate productivity, you need many teams of qualified programmers developing identical projects over many months but with different compilers.

Even when a compile-time benchmark is meaningful, you must evaluate the complete build system. Saving 2 seconds in a compile doesn't help if the make utility spends an extra 10 seconds doing its work. Also remember to look at the numbers as percentages when comparing two compilers. A 2-second difference between two compile times doesn't much matter if the overall compile takes 10 minutes.

Yes, quantitative benchmarks can be useful, but it's the quality of the overall compiler package that is most important. ■

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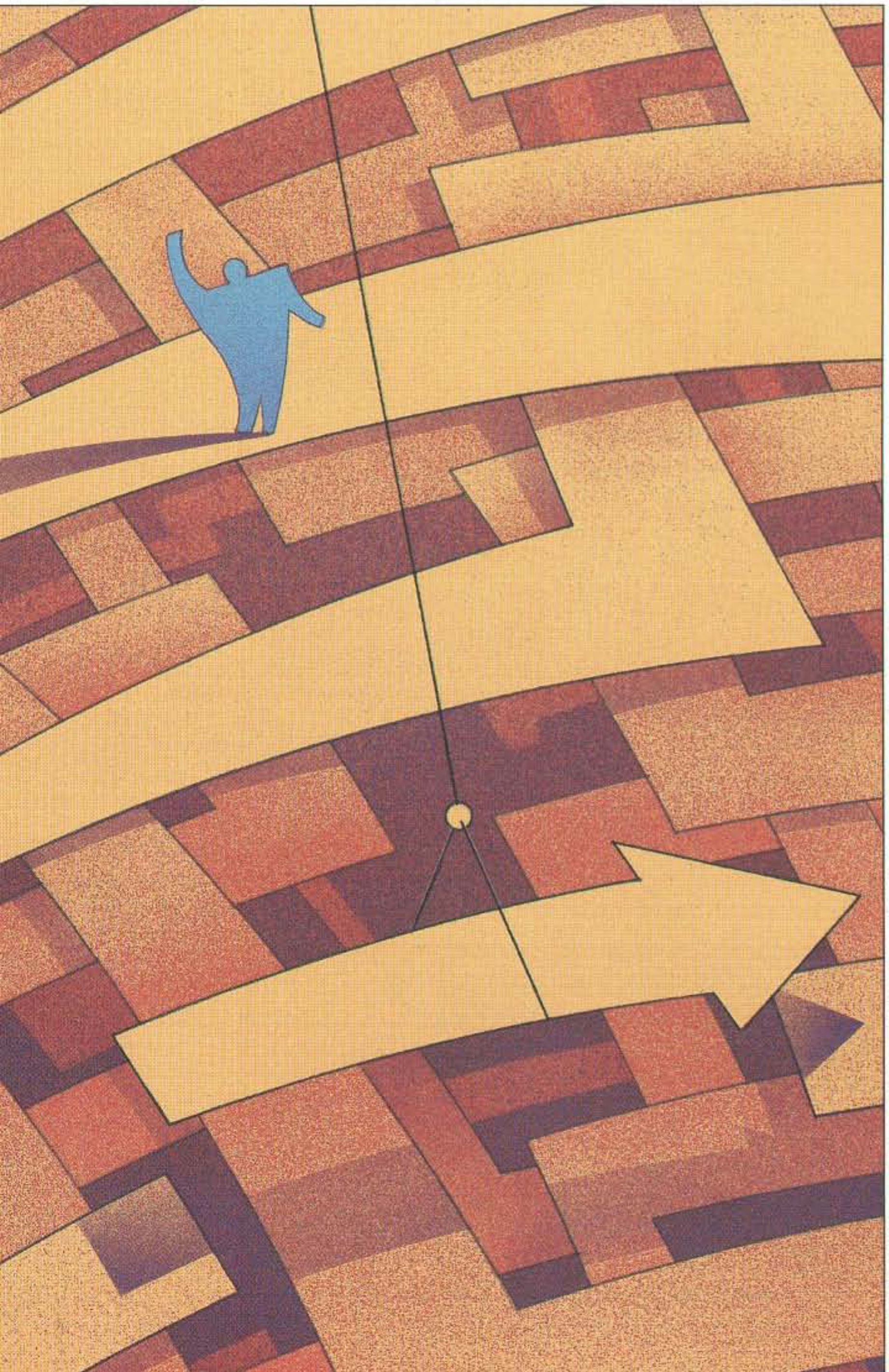
OPTIMIZING FOR TODAY'S CPUs

Modern compilers employ a full bag of tricks to make programs execute efficiently and to take full advantage of the special abilities of the new superscalar processors

ALEX LANE



MARK FISHER © 1994

Traditionally, optimizing code has been straightforward. Compilers improved software efficiency by reducing the number of instructions executed, making better use of the CPU's instruction set, maximizing the use of registers, minimizing memory references, and eliminating unused or redundant code. Currently, developers are creating optimization techniques to take maximum advantage of new processor features, such as on-chip caches, pipelining, and superscalar chip architecture.

The newest round of advanced microprocessors presents special challenges to compiler developers. For processor architectures built around two integer pipelines—such as Intel's Pentium, DEC's Alpha AXP, and Hewlett-Packard's PA-RISC—the compiler must schedule instructions to keep both pipelines full. Mips Technologies' Mips III (as implemented on the R4000 and R4400 chips) uses a number of greater parallel operations, so compilers for it must keep the superpipelines from stalling. With the IBM/Apple/Motorola PowerPC, the principal challenge is to get the maximum number of free instructions per clock cycle, and with the PowerPC 601 in particular, to give branch-prediction hints.

Goals of Optimization

Compilers generate code in a fairly mechanical way; a specific syntax generates a specific series of instructions. Unfortunately, this mechanical mapping process frequently generates sequences of assembly language instructions that contain redundant instructions or that perform simple operations in an efficient and time-consuming way.

Enterprising writers of early compilers incorporated so-called peephole routines that examined generated code as it was written to an output file, replacing awkward sequences with more efficient instructions. These techniques are known as

Optimizing with Pre- and Post-Compilers

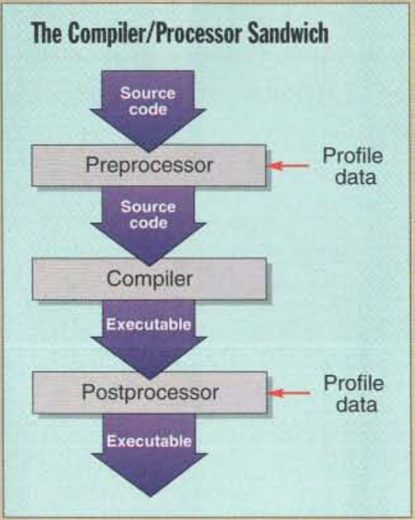
KEVIN DOWD

People talk about compilation as if it were a single process. In fact, every programming environment has other forms of preprocessors and postprocessors—programs that do something to your code before and after compilation, respectively.

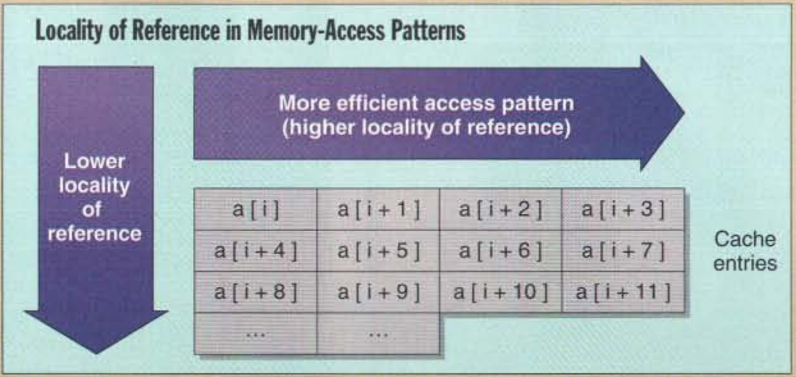
The preprocessor may set compile-time variables, expand other code inline, or conditionally delete sections of the input program. One well-known example is the C preprocessor (or `cpp`), which is part of all C programming environments. The `cpp` can process `#include`, `#define`, and `#ifdef` statements before passing C source code on to the compiler.

Other kinds of preprocessors translate macro languages (e.g., m4, ratfor, and FLECS), check for correctness (e.g., lint and ftncheck), modify source programs so that they can be profiled, translate between languages (e.g., f2c and FORTRAN 90 preprocessors), or place error-checking code inline.

Likewise, postprocessors are programs that do something to a piece of code after compilation—perhaps even after it has been linked into an executable file. Again, the goal may be to collect profiling statistics (e.g., Silicon Graphics' pixie); monitor memory activity for illegal references, as Pure Software's (Sunnyvale, CA) Purify does; or translate binaries from one brand of processor/operating-system combination to another, like Quorum Software System's (Menlo Park, CA) Equal Applications Adapter, DEC's VEST (VAX Executable Software Translator), and Echo Logic's (Holmdel, NJ) FlashPort. Also, each class of tools—preprocessors and postprocessors—includes programs that can help optimize performance both before and after compilation.


The Compiler/Processor Sandwich

Pre- and postprocessors *aid optimization.*


Locality of Reference in Memory-Access Patterns

A vectorizing preprocessor *can increase cache hit rates.*

Optimizing Preprocessors

Preprocessors are usually targeted at a particular application area or programming language. For numerically intensive applications, there are varieties of optimizing preprocessors that can either restructure loop constructs into more efficient forms or match them to optimized subroutine library routines. The dot product or inner product is an example of a common vector arithmetic construct:

```
do i=1,n
  s=s+a(i)*b(i)
enddo
```

A vectorizing preprocessor such as Kuck and Associates' (Champaign, IL) KAP/C, Pacific-Sierra Research's (Los Angeles, CA) Vast, or Numerical Algorithms Group's (Downers Grove, IL) Vecpar can recognize the dot product and replace it with a subroutine call or perhaps modify it inline for more efficiency. As a simple example, the following loop produces the same result as above, except it exposes more parallelism:

```
s0=0
s1=0
do i=1,n,2
  s0=s0+a(i)*b(i)
  s1=s1+a(i+1)*b(i+1)
enddo
s=s0+s1
```

Two loop iterations are visible at a time, thereby reducing loop overhead and improving opportunities for instruction overlap. Larger constructs, such as matrix multiplies, may be replaced with more efficient forms as well. In some cases, a preprocessor can use information that a profiler utility provides to help it choose where optimizations should be applied.

Exposing more parallelism is important, but perhaps a more important feature of vectorizing preprocessors is the ability to reduce certain types of memory system activity, particularly data-cache misses.

All caches are designed with the assumption that programs will exhibit some degree of locality of reference—that programs will ask for pieces of data that are "near" already-requested data, in space and in time. But a program that accesses memory without regard to locality of reference may perform poorly due to a high degree of cache misses. A vectorizing preprocessor can often reduce data-cache misses by interchanging loops or by tiling or blocking loop nests so that data is consumed more efficiently, in neighborhoods.

Optimizing Postprocessors

Because they work on compiled output, object-code postprocessors are generally not specific to particular types of applications. As you can imagine, however, an object-code postprocessor is usually closely tied to the architecture of its target computers. For performance, a common use of postprocessing is instruction-cache optimization (e.g., cord, which is part of the Mips software development tools); an executable file can be rewritten so that its subroutines share the instruction cache more efficiently. Often, this means reordering the relationships of heavily traveled sections of code so that they map side by side in the executable file's address space, reducing contention for particular portions of the cache. A postprocessor determines the best subroutine ordering by examining the results of an execution profile (e.g., those produced by pixie, gprof, prof, and Sun's SparcWorks Analyzer).

Another potential target for postprocessing is branch optimization. Many RISC processors use static branch prediction; the compiler guesses which way a conditional branch is likely to go at compile time, using some simple heuristics. In some cases, static prediction is backed by branch-target buffers—hardware that holds a few instructions from most recently executed branch instructions. To improve the performance of newly encountered branches, a postprocessor (with the help of a profiler) can rewrite the branch instructions in executable files so that they reflect the actual measured run-time behavior of the branches in question.

Postprocessors may also be written to tweak previously compiled programs for better performance or to make it possible to port binaries to other platforms. A vendor providing a new generation of processor, for instance, may wish to take advantage of additional instructions, changes in pipeline restrictions, or an expanded register set. In these cases, a postprocessor provides a path to increased performance without the need to re-port old programs. ■

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optimizations.

While the goal of optimization is to make code more compact, run faster, or both, optimization techniques can do only so much in the face of poorly organized programs or inherently slow algorithms. To address these problems, you can use a profiler utility that shows which parts of the code the CPU spends the most time executing. This identifies coding bottlenecks that you can often fix by using a different task organization, coding approach, or algorithm. Beginning developers often wonder why they need to use a profiler utility if they use a code optimizer, and vice versa. In fact, the two tools perform different and complementary functions.

Optimization Techniques

Machine-dependent

- **Global register allocation**
- **Register parameter passing**
- **Loop compaction**
- **Statement reordering**
- **Strip mining**
- **Instruction scheduling**

Machine-independent

- **Constant propagation (also known as copy propagation)**
- **Common subexpression elimination**
- **Invariant code motion**
- **Dead code elimination**
- **Dead store elimination**
- **Redundant load suppression**
- **Variable induction**
- **Loop jamming (often called loop fusion)**
- **Loop unrolling**
- **Loop rerolling**
- **Inlining**
- **Loop peeling**

A beneficial side effect of optimization is the ability to write more readable code. Before the widespread use of optimizing compilers, experienced programmers often adopted coding styles that favored better machine code generation over source code readability and maintainability. For example, multiplying a variable by a power of 2 in C might be coded as `var <<= 3` instead of `var * 8`. Alternatively, you could manually insert values for constants and expressions containing constants or use additional temporary variables to take calculations out of loops. Optimizers make such tactics unnecessary, freeing the developer to write more natural, readable code.

Optimization is an analytical process. After being parsed and analyzed, code is examined to extract the maximum amount of information, which can then be used to improve the code while preserving the programmer's original intent. Analysis answers the following questions: Does an expression inside a loop ever change during the loop's lifetime? Are there particular sections of code that will never be executed? Does this variable's value ever change? Is it ever used?

In typical cases, the greater the scope of optimization, the longer a compiler will take to generate code. Peephole optimizations use relatively little information and operate on a statement-by-statement level. You can get more information by examining blocks of code and identifying relationships between variables and expressions, although this takes longer. Global optimization looks at procedures and loops, and takes even more time.

The complexity of the optimization also affects overall code-generation speed. In any particular situation, it takes far less time to determine where to use arithmetic simplification—a technique in which certain expressions are replaced by simpler equivalents—than to analyze whether advanced optimizations, such as interchanging nested loops or reordering statements, can be used.

Some optimizations can be used with any processor, while others are tailored to specific chips. Machine-independent optimizations focus on generic code improvements, such as eliminating common subexpressions, making loops more efficient, and getting rid of dead code and uneeded variables. These generic optimization techniques need no knowledge of the hardware. Nearly all industrial-strength compilers today offer a full suite of such optimizations.

Machine-Dependent Optimizations

Unlike the optimizations discussed so far, machine-dependent optimizations take advantage of processor-specific knowledge to improve execution time and reduce overhead. They are particularly important for the new generation of processors, where new architectures require specific new approaches for optimization. For the most part, these kinds of optimizations represent improvements that are beyond the control of a developer who codes in a high-level language.

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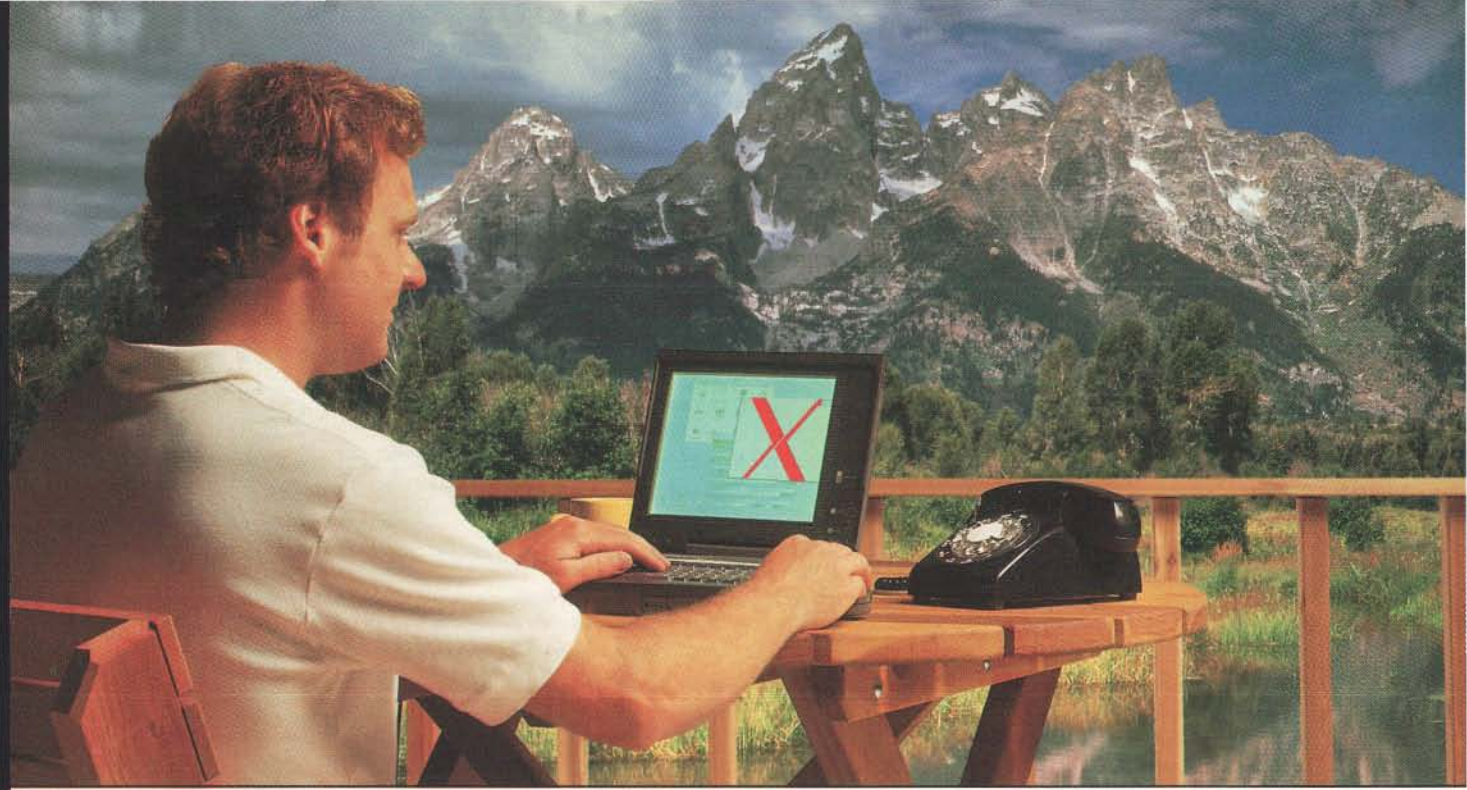

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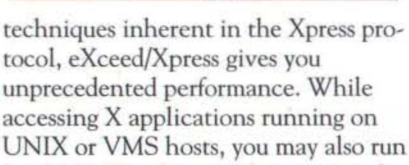

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One key to generating good code is keeping CPU registers filled with needed values, as opposed to shuttling the values between memory and the CPU. This is the idea behind *global register allocation*, which is a size and speed optimization that figures out what values should be stored in registers. The longer you can keep values in registers and prevent them from being written out to on-chip cache memory or, worse, to external memory, the better performance you get.

Register optimizations are particularly valuable in RISC architectures, which typically provide a large number of registers in the CPU. A similar optimization technique is *register parameter passing*, which bypasses the need to push function parameters onto the stack before the function call is made, by making sure that all needed parameters are preloaded into CPU registers.

Unfortunately, these techniques are of limited value in processors that have only a few registers. In the case of register parameter passing, if the function call does not result in direct execution of the function (a typical situation in environments like Windows), the technique cannot be used.

Loop compaction on most 80x86 processors is a machine-dependent optimization that takes advantage of highly efficient string-move instructions. A typical example with both C source code and the resulting assembly language instructions is shown in the listing "Loop Compaction." Surprisingly, the `stosw` instruction that improves 386 code will execute significantly more slowly on 486 and Pentium processors.

Loop Compaction

```
; for (i=0;i<10;i++)
;  x[i]=j+k;
;
mov cx, 10                  ;load cx w/ no. of iterations
lea di,word ptr [bp-108]    ;load di with adr of x[0]
push ds
pop es                      ;load es with data segment
mov ax,word ptr [bp-6]      ;get value of n
add ax,word ptr [bp-8]      ;add value of m
rep stosw                   ;ZOOM!
mov word ptr [bp-2],10      ;set i to 10
```

In pipelined and superscalar processors, techniques that keep instructions executing while minimizing memory paging and register swapping operations are important. For example, consider a loop in C written as

```
int x[ROW][COL];
for (j=0;j<ROW;i++)
  for (i=0;i<COL;j++)
    x[i][j]=foo(bar);
```

For sufficiently large values of `ROW` and `COL`, this suffers from widely separated addresses—called a *stride* in some circles—for successive values of `x[i][j]`. Running this code will likely result in a lot of memory paging. However, just by interchanging these nested loops, successive values of `x[i][j]` will be near one another and will reduce the number of paging operations necessary to run the code.

Another commonly used optimization is *statement reordering*. Here, computations are done in a different sequence than specified in the source code. When applied to floating-point calculations, this optimization is likely to produce slightly different results than the originally specified code. This is due to the accumulation of round-off errors that differ from those you would obtain using the original code.

An interesting technique called *strip mining* isn't an optimization in itself, but it can be used with other techniques to boost performance. The term is taken from a technique used with supercomputers.

Strip mining is particularly useful for optimizing matrix multiplication on cache-based, superscalar processors such as the Alpha, Pentium, PowerPC, or PA-RISC chips. The key lies in transforming the ponderous row-column algorithm, which (if matrix C is an n × n product of matrices) looks like this:

```
for (i=0; i<n; i++)
  for (j=0; j<n; j++)
for (k=0,C[i,j]=0; k<n; k++)
  C[i][j] += A[i][k]*B[k][j];
```

into one that effectively multiplies square subblocks of the matrices. The listing "Strip Mining" shows what the optimized code might look like.

In the sample code, `blk_factor` is a

WHO'S ANGUS?

processor-dependent number selected to make best use of the CPU's cache that, in effect, causes the matrices to be multiplied in blocks of `blk_factor` size. (The variable `init_strip_sz` is used to multiply a smaller block if the size of the matrices being multiplied is not evenly divisible by `blk_factor`.)

In creating this code, the optimizer strip-mined each of the original loops to create *block loops* and *strip loops*. The block loops, which cause blocks of memory to be paged into and out of the cache, were interchanged to move them to the "outside" of the nest of loops. The strip loops, which perform calculations within each block, were moved to the inside of the nested loops.

Arranged in this way, the computation makes best use of the processor and memory system, since you can use cached matrix blocks repeatedly before discarding them and intermediate results can be enregistered longer than otherwise possible. The result is nearly an order of magnitude improvement in performance for n>150.

However, the optimized code is obviously much more complicated than the original. Further, the size of `blk_factor` and the ordering of the loops can vary from processor to processor. (In this example, the transformed code was generated for an IBM RS/6000, which has a 64-KB cache and four-way set associativity, using KAP/C from Kuck and Associates of Champaign, Illinois.) For this reason—and from a readability standpoint—developers should write code as shown in the original and let the optimizer take care of the details.

PENTIUM OPTIMIZATIONS

When Watcom International revamped its C/C++ compilers to take advantage of the Pentium's superscalar architecture, the company got an unintended bonus: integer code that executes substantially faster on 486s. Even though the 486 doesn't have a true superscalar architecture like the Pentium, its pipeline stages can overlap a lot more than Watcom's 486 code could achieve. "Two years ago, we introduced 486 optimizations, and I think the performance benefit was about 5 percent," says Dave Boswell, Watcom's vice president of marketing and sales. "We thought we were really doing something swell. But with Pentium optimizations, we got an average of 30 percent to 40 percent improvement on a 486."

Strip Mining

```
int init_strip_sz = (n-1)%blk_factor + 1;
int i_blk, i_strip_sz, i_strip_lb, i_strip_ub;
int j_blk, j_strip_sz, j_strip_lb, j_strip_ub;
int k_blk, k_strip_sz, k_strip_lb, k_strip_ub;

i_strip_lb = 0;
i_strip_sz = init_strip_sz;

for (i_blk = 1; i_blk <= n; i_blk += blk_factor ) {
   i_strip_ub = i_strip_ub + i_strip_sz - 1;
   k_strip_lb = 0;
   k_strip_sz = init_strip_sz;
   for (k_blk = 1; k_blk <= n; k_blk += blk_factor ) {
      k_strip_ub = k_strip_ub + k_strip_sz - 1;
      j_strip_lb = 0;
      j_strip_sz = init_strip_sz;
      for (j_blk = 1; j_blk <= n; j_blk += blk_factor ) {
         j_strip_ub = j_strip_ub + j_strip_sz - 1;
         for (i = i_strip_lb; i <= i_strip_ub; i++)
            for (j = j_strip_lb; j <= j_strip_ub; j++)
               for (k = k_strip_lb; k <= k_strip_ub; k++)
                  C[i][j] += A[i][k] * B[k][j];
         j_strip_lb += j_strip_sz;
         j_strip_sz = blk_factor;
      }
      k_strip_lb += k_strip_sz;
      k_strip_sz = blk_factor;
   }
   i_strip_lb += i_strip_sz;
   i_strip_sz = blk_factor;
}
```

Another important optimization for pipelined architectures is *instruction scheduling*. This helps prevent processor pipelines from stalling. In Pentium and 486 processors, for example, if an address or register needed by a particular instruction is not available because a previous instruction has not finished processing, an AGI (Address Generation Interlock) occurs. In the following code example, an AGI occurs after the second instruction because the first has not completed execution:

```
inc eax
mov ebx,[eax] ; stalled owing
              ; to AGI
inc ecx
```

A good instruction scheduler would rearrange the instructions as follows, to allow uninterrupted execution:

```
inc eax
inc ecx
mov ebx,[eax]
```

AGIs are particularly troublesome for Pentium processors, since two instructions can execute in parallel in the final three stages of the integer pipeline, in separate U- and V-pipes, creating more stalling opportunities in longer instruction sequences. In the following example,

```
;U-pipe      V-pipe
 inc ebx     inc ecx
 inc edx     mov  eax,[ebx]
```

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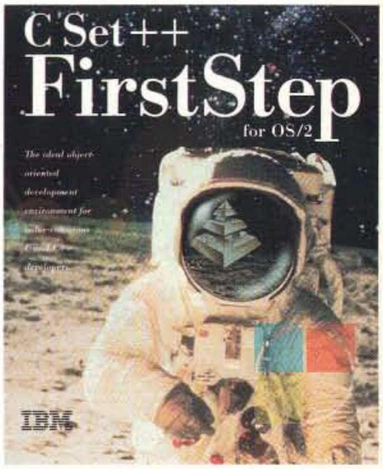
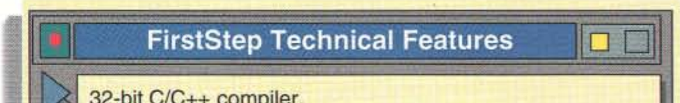


start right here.



FirstStep Technical Features

- 32-bit C/C++ compiler.
- Visual PM Debugger.
- C++ Collection Class Libraries.
- Developer's ToolKit new V2.1.
- WorkFrame/2 (supports DOS, Windows and OS/2 tools).
- Open and configurable integration framework.
- Seamless integration of multiple edit, compile & debug tools.

Professional developers may require the additional features of C Set ++ V2.1, our professional developer's package including high-end tools, optimization and full support and service.

To order C Set ++ FirstStep for OS/2, or for further information call **1-800-342-6672** (U.S.A.) or **1-800-465-7999**, ext. **670** (Canada). Or contact your local IBM software dealer.

C Set ++

IBM

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Circle 105 on Inquiry Card.

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- 400 FREE Symbols

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```
;stalled owing to AGI
 mov esi,[mem]
```

an AGI occurs after the second instruction is encountered in the V-pipe. This halts execution in both pipes for one clock cycle until the first instruction completes. Properly scheduled, the code would look as follows:

```
;U-pipe        V-pipe
 inc ebx        inc ecx
 inc edx        mov esi,[mem]
 mov eax,[ebx]
```

To Optimize or Not to Optimize?

There are two good reasons why you might not want to always run the optimizer when compiling code. The first is time. It's not unusual for compilers with aggressive optimizers to increase code generation time by 200 percent to 300 percent, and this figure may rise for compilers that implement advanced, machine-dependent optimizations.

The second reason concerns debugging. Traditional source-level debuggers rely on a correspondence between the source code and the object code. When you introduce moved code, compacted (or worse, interchanged) loops, eliminated variables, inlining, and so on, optimized code often bears little resemblance to the source code from which it came. This makes debugging optimized code nearly impossible, except at the assembly language level.

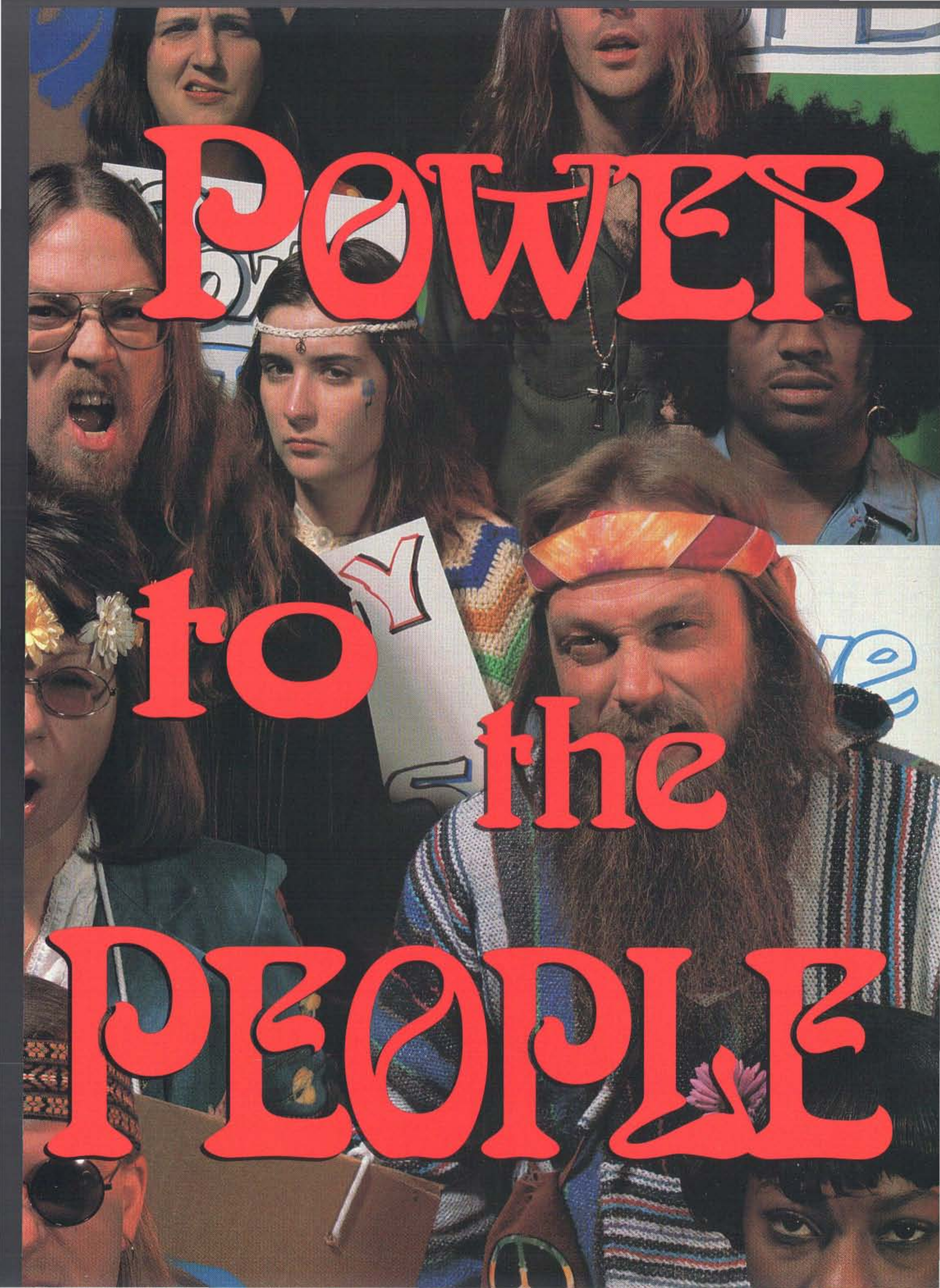
Various approaches to debugging optimized code have been tried, such as noting what line of original source code generated particular instructions, and others are under development. Currently, though, the standard approach to software development is to debug using unoptimized code, and only then to run the optimizer to generate the final executable. Any bugs that are introduced during optimization must be chased down at the assembly language level.

As the complexity of processors increases, today's optimizing compilers are becoming more complex. In addition to providing the traditional machine-independent optimizations that mimic what a determined developer might do to make code faster or smaller, the compilers are beginning to perform machine-dependent optimizations that promise quantum boosts in performance. ■

Alex Lane is a Colorado-based writer, speaker, and consultant. He can be reached on the Internet or BIX at a.lane@bix.com.

Circle 69 on Inquiry Card.

POWER to the PEOPLE



Now more than ever, we're giving power to the people. Our Pentium-based PCI systems are priced hundreds, sometimes thousands of dollars less than competitors' comparably configured Pentium systems. That's PC power everyone can afford!

Best Overall
Systems Supplier

1993

Best Service
Best Mail Order Co.

Best Service

You Got It, Baby!

By the Time We Get to Woodstock

When historians write the history of the personal computer industry years from now, they'll remember Gateway 2000™ as the radical PC manufacturer that gave power to the people by selling the highest-quality, latest-technology computers at affordable prices. By showing PC buyers a level of service they thought was a throwback to the peace and love era. By giving real meaning to the tattered, worn-out term "value."

When Gateway 2000 came onto the scene, the establishment computer companies were charging whatever they wanted for technology. Gateway was a real downer to them because we began selling the same technology for a whole lot less. And the buyers were very smart. They shouted, "Hell no, we won't go," to the big companies, and took a chance on the revolutionary Midwest company called Gateway 2000. Soon a great legion of people — even more than Woodstock attracted — was buying Gateway PCs.

Today, Gateway 2000 is bigger than many of the companies for which it was an alternative. So why should you buy a Gateway computer today? Same reasons as in the beginning. You still get the best price, quality and service from us.

Demonstrations

That's why, for the third consecutive year, we swept *Computer Shopper's* Best Buy Awards, winning every product award we were eligible for and being chosen as the Best Overall Systems Supplier. (Thanks, *Shopper* readers!) That's why we took five top honors in *PC World's* World Class Awards, including Best Mail Order Company and Best Service and Support. (Thanks, *PC World* readers!) And even though we're now a Fortune 500 company, we still champion anti-establishment thinking. Check it out. You'll find GW2K is far-out, groovy and totally unreal!

We dedicate this ad to the memory of Sol Pessin, one of our special customers who believed in us during the early days. We'll miss you, Sol.

GATEWAY2000

"You've got a friend in the business."®

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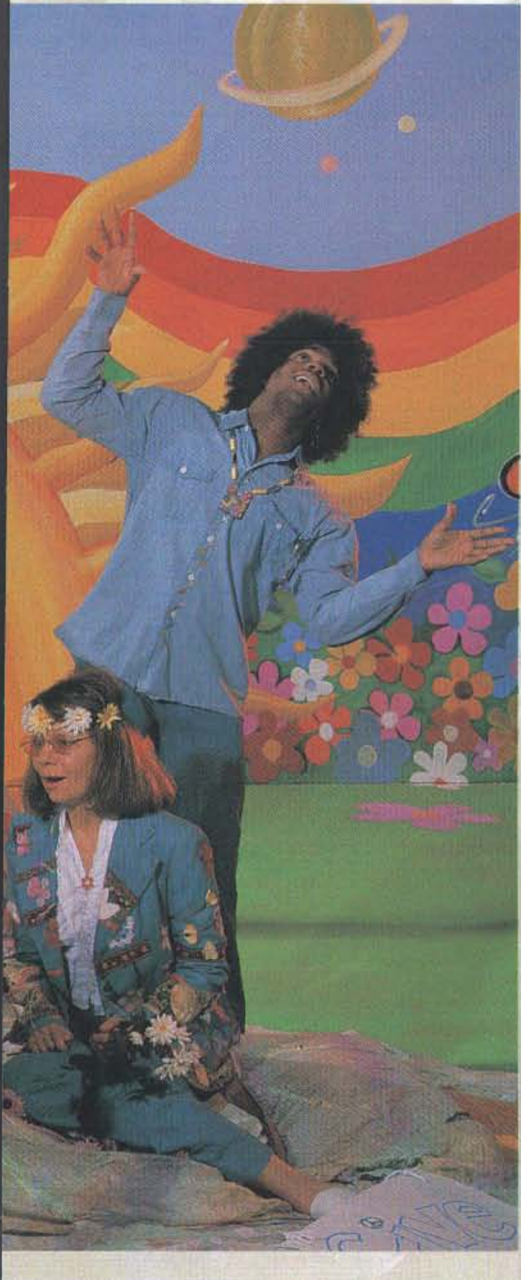

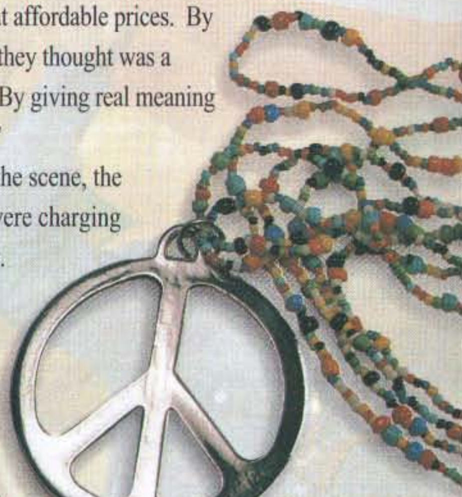

Gateway Gives You Performance

The Eagle has Landed

When Gateway introduced a Pentium™-based system — loaded — for under $4,000, everybody in the industry knew the Eagle had landed. The best PC value on the planet had arrived! The editors of *PC/Computing* heralded the accomplishment by naming it Best Desktop of 1993.

Then we topped our achievement by offering *four* Pentium processor-based systems, including a *new 66MHz model*, priced from $2,495 to $3,995. Now that's a giant leap in value for one of the highest-performance PCs on earth. These systems are tomorrow's technology available today at affordable prices — only from Gateway.

Our P5 systems include Intel's 64-bit Pentium processor, which moves instructions and data twice as fast as a 486 system. The P5 PCs get another performance boost from a PCI local bus. The PCI bus can operate 10 to 15% faster than a VESA® local bus. The PCI bus' "plug and play" feature makes your PC easier to use, too, by automatically configuring peripherals.

Space-Age Video

The PCI bus is coupled with a space-age video system, with 2MB standard video memory giving you 64,000 colors at 1024 x 768 resolutions. The PCI-based video system uses a high-performance 64-bit interface to video memory that achieves 16 million colors, true 24-bit, in VGA and SVGA resolutions. Our standard video system gives you the best overall performance on the market.

The net effect of the PCI local bus and this video system is performance that will send you into orbit. It's definitely far-out!

486 PCI Local Bus System is A-OK

The PCI local bus and PCI video system are also available in a 66MHz 486DX2 system, Intel® verified to be Pentium upgradable. Another A-OK value in a high-performance system from Gateway!

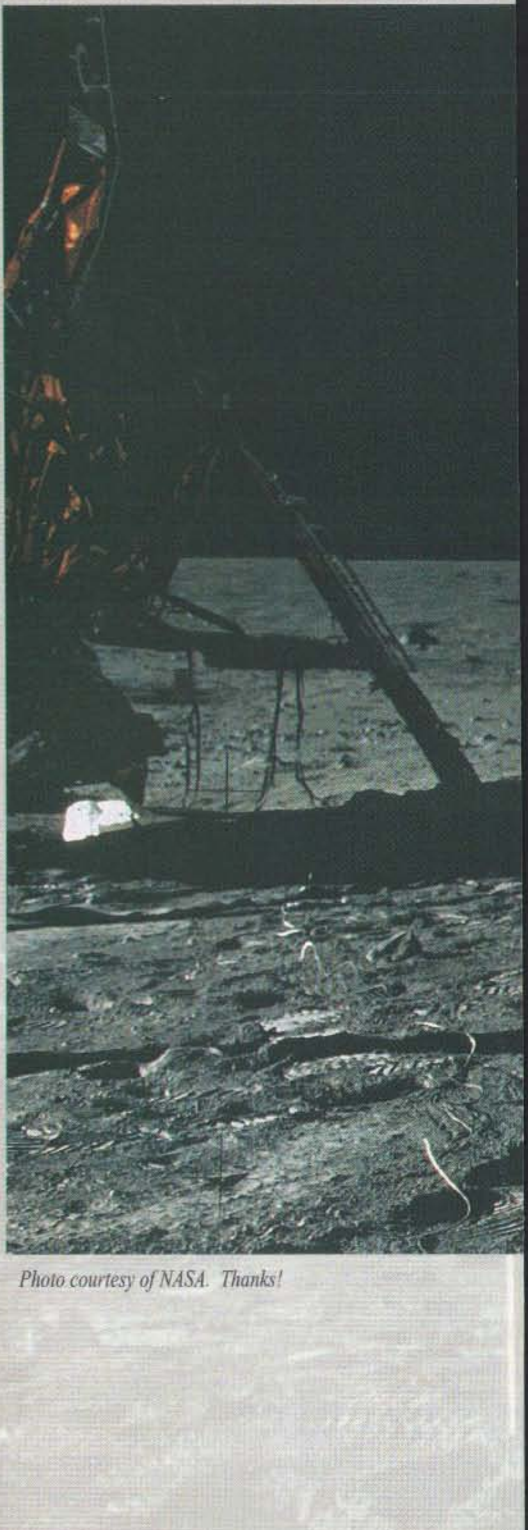

Photo courtesy of NASA. Thanks!

GATEWAY2000

"You've got a friend in the business."®

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That's Out Of This World!

Our P5-60 was named Best Desktop of 1993 by the editors of PC/Computing. *"(It) is nearly twice as fast as its nearest competitor at Windows operations. When it comes to top-of-the-line desktop systems, you can't beat high performance for a low price," states the editorial.*

Best Desktop
of 1993

New this month is our 66MHz Pentium-based system for only $3,995.

intel inside

Be A Trend-Setter With A

Our 4DX2-66V model has to be one of the most highly decorated PCs in the history of the industry. For good reason! Like other Gateway VESA and integrated systems, it's a very attractive value.

4DX2-66V
Best Desktop

4DX2-66V
Best Windows PC

4DX2-66V

4DX2-66V

Pournelle
4DX2-66V

4DX2-66V

Gateway VESA Or Integrated PC

Our Family PC comes with CD-ROM, sound card, speakers, joystick, fax/modem and multimedia software. You choose one software option from five great Family PC multi-title packages. Some of the outstanding titles you can get are: Microsoft Works,™ Dinosaurs and Encarta,™ Cinemania,™ Time Almanac, Links Golf Collection, The Animals, MicroProse™ Game Pack, MECC Elementary Education Pack — and more!

You'll be a trend-setter in your office or neighborhood if you choose a Gateway VESA® or integrated system because there's nothing more fashionable than a great buy. Everybody wants one!

VESA a Go-Go

Our VESA local bus machines give you go-go performance at a fab price. VESA, which stands for Video Electronics Standards Association, assures you of compatibility with any VESA peripheral. These systems are also upgradable to a Pentium™ OverDrive™ Processor if you need more processor power in the future.

Integrated PCs Sock it to 'Em

Our integrated systems definitely sock it to the competition. Offered in space-saving mini desktop cases, our local-bus integrated PCs give you twice the video performance available in many standard desktop machines. In fact, video performance in our integrated systems is similar to, or better than, that found in many of our competitors' high-end systems.

Of course these machines are also upgradable to a Pentium OverDrive Processor.

Our special Family PC, with full multimedia capabilities and some exciting software choices, is priced at only $1,995. Ask us for details.

If you want a mod PC for the fewest dollars possible, you want an integrated system from Gateway. You can bet your bippy on that!

Energy Stardom

All Gateway 2000™ VESA local bus and integrated systems wear the Energy Star seal to show they comply with energy-saving guidelines established by the EPA. Our commitment to the Energy Star program is just one of the ways we're working to help the environment — and to help you save money!

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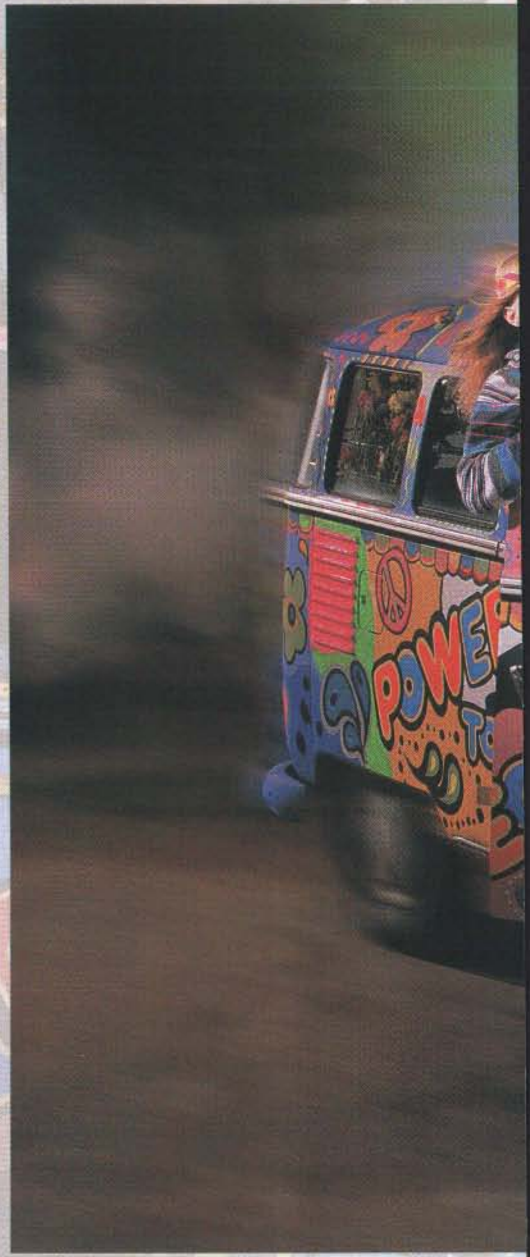
For The Rolling Stone In You.

Whether you travel constantly from continent to continent or occasionally from office to home, Gateway has the perfect portable PC to keep you rollin' on down the highway.



Easy Rider

The revolutionary HandBook® 486 gives you more MIPS per pound than any other PC! Plus, the HandBook is the answer to the most common question seasoned portable users ask themselves: should I take my portable or not? Is it worth the hassel? With a HandBook, you'll never ask yourself that question again. It's so small and light, it's effortless to carry. The decision is automatic: of course you'll take your HandBook. You'll never want to be without it! The HandBook is a truly extraordinary product that will forever change the way you use a PC.

The HandBook has all the features that matter to you, too, including: ideal weight and size (less than 3 pounds, about the size of a day-planner); plenty of power (genuine Intel SL Enhanced 486 processor); great screen (bright, 7.9-inch backlit VGA display); comfortable 78-key keyboard; EZ Point integrated pointer (no need to carry a clumsy mouse); excellent battery life (up to four hours); suspend/resume (a handy feature that allows you to stop work any time and resume later without losing data or restarting the system).

Psychedelic Day-Tripper

Psychedelic color for flower children of all ages. That's the Gateway 2000™ ColorBook™. The ColorBook includes: a brilliant, 9.4-inch VGA color screen (dual-scan STN color is the latest technology in color displays); 486 performance (genuine Intel SL Enhanced 486 processor); excellent portability (weighs less than 5.7 pounds and is ultra-thin — just 1.77 inches); simultaneous video up to 1024 x 768 resolution; a built-in trackball (very easy to use); two PCMCIA Type II slots (can also be used for one Type III PCMCIA card); great battery life (up to four hours); suspend/resume feature.

If you want dazzling color at a mono price, look no further than the ColorBook.

GATEWAY2000

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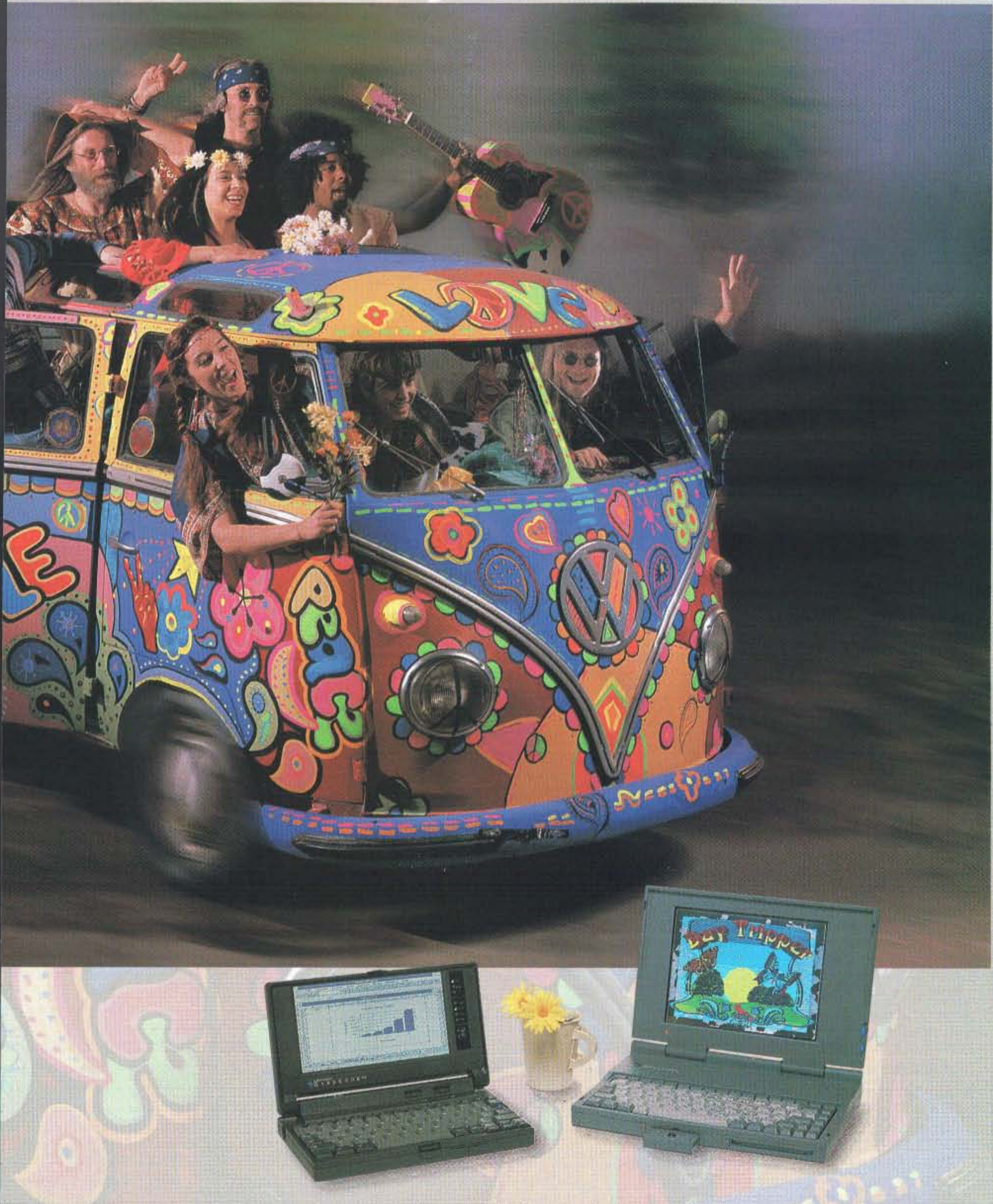
800-846-2058

Gateway Has Groovy Portables.



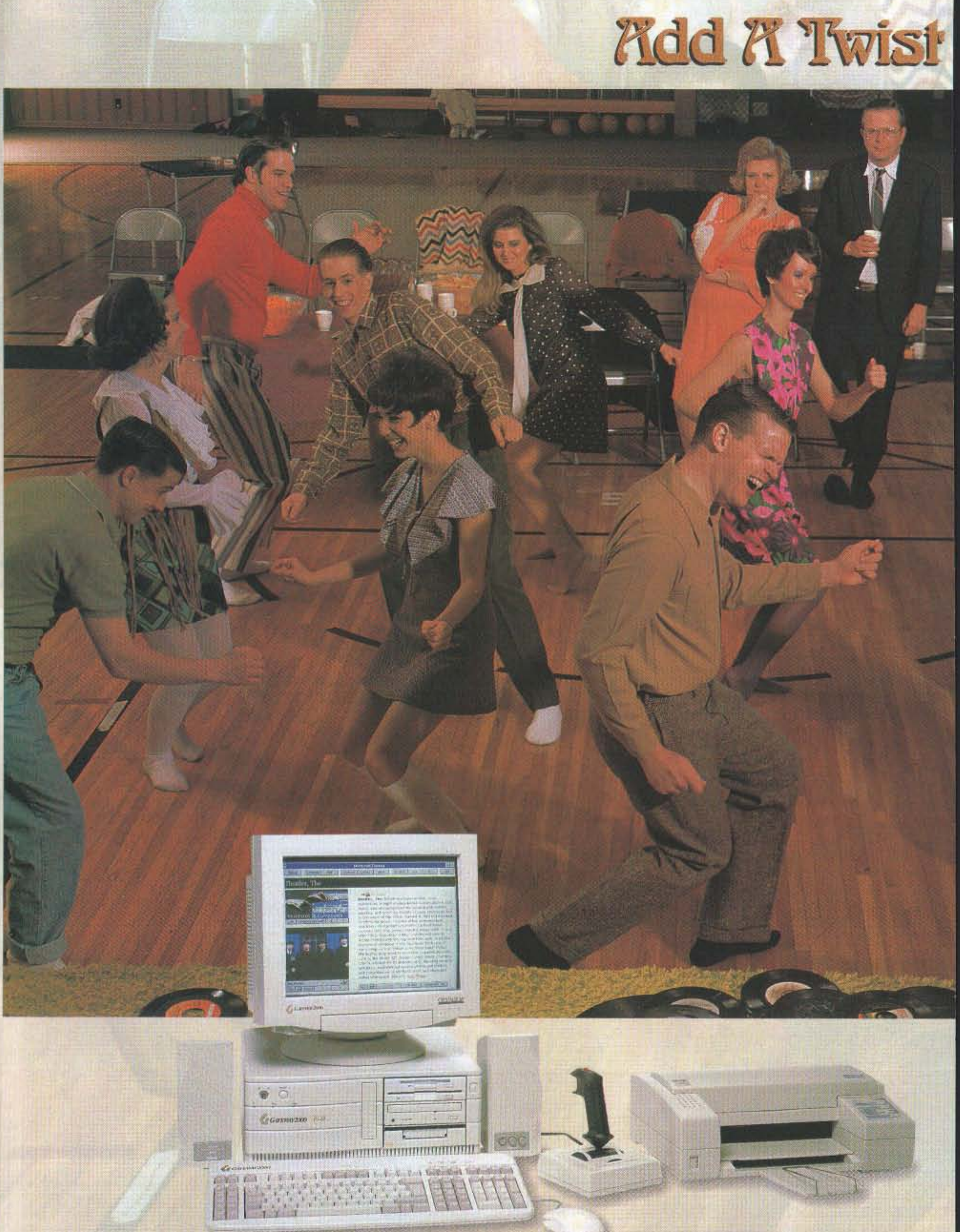
On your next trip, be sure to take along a good book.
That's a HandBook or a ColorBook from Gateway 2000!

PC WORLD
HandBook
Best Subnotebook

HandBook
Best Subnotebook

BYTE
HandBook
Best Hand-Held/Palmtop

intel inside



Shown here is our 4DX2-66V model loaded with options including a 17-inch CrystalScan monitor, combo floppy drive, multimedia kit with optional Yamaha speakers, Colorado Memory Systems tape backup unit, FlightStick and Epson Stylus 800 printer. With multimedia, the sights and sounds of any era are available to you with a click of your mouse. Right on!

PORTABLES

HANDBOOK® 486

- Weight: 2.94 Lbs.
- Dimensions: 9.75" x 5.9" x 1.6"
- SL Enhanced Intel® 486 Processor
- 4MB RAM (expands to 8MB or 20MB)
- 80 to 130MB IDE Hard Drive
- 7.9" Backlit VGA Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 1 PCMCIA Type II Slot
- EZ Point™ Integrated Pointer
- 78-Key Keyboard
- Parallel, Serial & PS/2 Ports
- MS-DOS,® Windows™ & Serial Transfer Cable

HANDBOOK 486SX-25

With 25MHz 486SX CPU and 80MB Hard Drive

$1495

HANDBOOK 486DX2-40

With 40MHz 486DX2 CPU and 130MB Hard Drive

$1995

HANDBOOK PACKS

Traveler's Packs:

- Microsoft Works for Windows, case, extra battery & PCMCIA 9600/2400 fax/modem. **$369**
- Microsoft Works for Windows, case, extra battery & PCMCIA TelePath™ fax/modem. **$489**

Presenter's Pack:

- PCMCIA VGA adapter, Asymetrix® Compel & case. **$319**

PORTABLE OPTIONS

PCMCIA Cards:

- TelePath 14400/14400 fax/modem. **$319**
- 9600/2400 fax/modem. **$199**
- Ethernet adapter. **$189**
- Token Ring adapter. **$449**
- HandBook VGA adapter. **$229**

Batteries:

- 2.2Ah NiMH batteries. **$89**
- Alkaline battery pack. **$29**

Diskette Drive:

- HandBook external 1.44MB. **$99**

Cases:

- ColorBook **$49** HandBook **$55**

Extended VIP Warranty:

- We'll ship a replacement within 24 hours during warranty. Point of sale only. **$100**

COLORBOOK™

- Weight: Under 5.7 Lbs.
- Dimensions: 11.7" x 8.5" x 1.77"
- SL Enhanced Intel 486 Processor
- 4MB RAM (expands to 8, 12 or 20MB)
- 3.5" 1.44MB Diskette Drive
- Removable 80 to 250MB IDE Drive
- 9.4" VGA Dual-Scan STN Color Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II Slots
- Integrated Trackball (2 buttons)
- 85-Key Keyboard
- Parallel, Serial & PS/2® Ports
- External VGA Port
- MS Works for Windows™
- MS-DOS and Windows

COLORBOOK 486SX-25

With 25MHz 486SX CPU and 80MB Hard Drive

$1995

COLORBOOK 486SX-33

With 33MHz 486SX CPU and 170MB Hard Drive

$2395

COLORBOOK 486DX-33

With 33MHz 486DX CPU and 250MB Hard Drive

$2795

COLORBOOK PACKS

Traveler's Packs:

- Case, extra battery & PCMCIA 9600/2400 fax/modem. **$329**
- Case, extra battery & PCMCIA TelePath fax/modem. **$449**

NOMAD 450DXC

- Weight: 6.2 Lbs.
- Dimensions: 8.5" x 11" x 2.2"
- 50MHz Intel 486DX2 CPU
- 8MB RAM
- 3.5" 1.44MB Diskette Drive
- 200MB IDE Hard Drive
- 8.4" Color Active Matrix Screen
- NiMH Battery & AC Pack
- Simultaneous Video with 1MB
- 79-Key Keyboard & Mouse
- 9600/2400 Fax/Modem
- 1 Parallel, 1 Serial Port
- MS-DOS, Windows & Works

$3995

MULTIMEDIA KIT

Here's everything you need to add multimedia to any Gateway desktop PC. You won't find a better holiday price anywhere!

- Gateway 2000 16-Bit Sound Card, Sound Blaster-™Compatible
- Double-Speed CD-ROM
- 2 Labtec® Speakers
- Microsoft Encarta & Corel Photo CD Software
- Gateway System CD

$299

For system configurations that include a CD-ROM drive: **$132**
Only with system purchase.

Printed on recycled paper with soy inks.

Gateway 2000 is a corporate sponsor of
GLOBAL RELEAF

SOFTWARE & EXTRAS

If a system comes with "choice of application software," choose one of the following packages:

- Microsoft Excel for Windows™
- Microsoft Word for Windows™
- Microsoft Word and Bookshelf '92,® CD-ROM Edition
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- The Entrepreneur Pack (Works,™ Publisher,™ Money™ & games)
- Borland Paradox® database and Quattro® Pro for Windows spreadsheet
- Microsoft Access™ for Windows

With desktop and selected portables you also get the following software and extras at no additional charge:

- MS-DOS 6.2 & Windows for Workgroups 3.11
- CoSession™ Host Remote Diagnostics (with all modems)
- Kiplinger's™ CA-Simply™ Money
- QAPlus Diagnostics
- Gateway Computer Glossary
- Gateway Mouse Pad

Systems with CDs also include:

- Gateway System CD with Microsoft Multimedia Pack™
- Multimedia On-Line User's Guide
- Gateway Mall On-Line Catalog

SERVICE

Every Gateway system is backed by:

- 30-Day Money-Back Guarantee
- One-Year Limited Warranty
- Lifetime Toll-Free Technical Support
- On-Site Service Available To Most Locations
- Lifetime BBS Membership
- FaxBack Automated Fax Service

Our money-back guarantee does not include shipping. On-site service is provided at no charge during warranty if our technicians determine it is necessary. If you'd like to read our warranty and guarantee policies, please call for a free copy.

intel inside®

Networking

Intel EtherExpress™

A 16-bit Ethernet adapter from a world leader in networking. **$105** Twisted Pair or BNC Kit (BNC kit includes cable, connector, terminator and card).

Ethernet Adapter from 3Com®

Manufactured by 3Com for Gateway. Features parallel tasking architecture with a high level of integration. **$105** Twisted Pair. **$125** BNC Kit (includes cable, connector, terminator and card).

Monitors

CrystalScan® 17-Inch Monitor

Non-interlaced color monitor, .26mm dot pitch. If your system comes with a 14-inch monitor, you can upgrade to this monitor for **$430**. If your system comes with a 15-inch monitor, you can upgrade for **$350**. (Prices good only for upgrades at the time of system purchase.)

Printers

Epson® 1070+ Printer

Here's a value-priced, wide-carriage dot matrix printer that gives you 225cpi in draft mode, 10 letter-quality fonts and 4 scalable fonts. Quiet, too (46.5db)! **$359**

Panasonic Color-Capable Printer

Add color to your documents with this 24-pin dot matrix printer. Includes Adobe Type Manager.® KX-P2123 **$259**; Color Option **$50**

Epson Stylus 800 Ink Jet Printer

Great laser quality at an even greater value. Measuring only 17 inches by 10.5 inches, the Stylus 800 has seven different typefaces and prints an extra-quiet 150 characters per second at 360dpi. Parallel cable included. **$289**

Epson ActionLaser 1500 Laser Printer

The ActionLaser delivers professional-quality printouts with crisp, sharp images, black blacks and smooth, "jag-free" lines. It also features a fast six-page per minute print speed, 14 resident fonts, 300 x 300dpi, and 1MB memory expandable to 5MB. Parallel cable included. **$669**

TI MicroLaser™ Pro 600

This Texas Instruments laser printer redefines value in high-performance printing with 6MB RAM standard, a fast eight pages-per-minute print rate, 500-sheet capacity and true 600dpi quality.

With 23 PostScript® Fonts: **$1,449**
With 65 PostScript Fonts: **$1,629**

Lexmark 4039 10R

The printer for tomorrow's technology! Featuring a fast, RISC processor it switches between PostScript and PCL5 printer languages automatically and prints at a remarkable 10 pages per minute at true 600dpi. **$1,399**

Easy Payment Options

We make it easy for you to buy a Gateway PC, too! We accept most major credits cards and C.O.D. terms, with net 30-day terms and leasing options available to qualified commercial customers.

You can also apply for our new Gateway 2000™ DuoLine™ MasterCard® Card, issued by Dial National Bank, which lets you make purchases from Gateway and anywhere else MasterCard is accepted by giving you two lines of credit — one for Gateway purchases and one for all other purchases. For Gateway purchases, the card has no annual fee and a low variable interest rate of just 12.9% APR. For other transactions, you get a variable interest rate of 13.9% APR and a low $18 annual fee.*

**Cash advance fee is $1 plus 2% of the amount of the cash advance, but not less than $5 nor more than $10. Financing is available on approved credit with the Gateway DuoLine MasterCard, issued by Dial National Bank, Des Moines, Iowa.*

GATEWAY2000
"You've got a friend in the business."®
800-846-2058

Our '60s models are all Gateway 2000 employees and their children who relived the flower-power era for this ad.

To Your Gateway PC!

When you've picked the PC you want, take a look at the options listed here to make your system as productive and fun as possible. Sorry, the peripherals listed here are sold only with the purchase of a system. For details on our complete line of extras for Gateway customers, ask for our special add-on components division when you call.

Multimedia

Multimedia Kit

Here's everything you need to add multimedia to your Gateway PC:

- Gateway 2000™ 16-bit CD-quality sound card, compatible with Sound Blaster™ cards, with MIDI/game port, mic in, stereo line in/out
- Double-speed CD-ROM drive, tray-loading, compatible with music CDs, multisession photo CDs and CD-ROM titles
- 2 Labtec® speakers that attach to your PC monitor
- Microsoft® Encarta & Corel Photo CD software
- Gateway 2000 System CD with Microsoft Multimedia Pack™

$299

For system configurations that include a CD-ROM drive, get the multimedia kit without CD-ROM drive for: **$132**

Yamaha® YST-M10 Multimedia Speakers

New! The small speakers that sound big. And come with a tiny price. This free-standing, self-powered speaker set is a great value! **$75**

Altec Lansing Multimedia Speakers

Get superior stereo sound with these top-rated Altec Lansing ACS-300 speakers with separate powered subwoofer. **$219**

CH FlightStick

The joystick that's recommended by our kids! With a sensational "feel" and rugged construction, this is the last joystick you'll ever have to buy! **$35**

Communications & Storage

TelePath™ II Fax/Modem

Internal fax/modem, 14,400bps modem, V.32bis, with 14,400bps fax capability. Package includes data and fax communication software, plus a CompuServe® trial membership. **$159**

Cardinal® 2400 Fax/Modem

Internal fax/modem, 2,400bps modem, V.22bis, with 9,600bps fax capability. Package includes data and fax communication software. **$49**

Colorado Memory Systems® TBU

250MB internal automatic tape backup unit copies up to 9.5MB per minute. Comes with Windows and DOS software, one tape and cable. **$159**

INTEGRATED & VESA SYSTEMS

4SX-33/4DX-33

- Intel 33MHz 486SX or DX CPU
- 4MB RAM
- 212MB 13ms IDE Hard Drive
- Local Bus Graphics with 512KB
- 3.5" Diskette Drive
- 14" Color CrystalScan® 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 101-Key Keyboard & MS Mouse
- MS-DOS® 6.2 & WFW™ 3.11
- MS Works for Windows™
- EPA Energy Star Compliant

***4SX-33* - $1295**

***4DX-33* - $1495**

4DX2-50/4DX2-66

- Intel 50 or 66MHz 486DX2 CPU
- 4MB RAM, 128KB Cache
- 424MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- 3.5" Diskette Drive
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- AnyKey® Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
- EPA Energy Star Compliant

***4DX2-50* - $1795**

***4DX2-66* - $1995**

4SX-33V

- Intel® 33MHz 486SX CPU
- 4MB RAM
- 212MB 13ms IDE Hard Drive
- VLB™ Graphics with 1MB
- Local Bus IDE Interface
- 5.25" & 3.5" Combo Drive
- 14" Color CrystalScan® 1024NI
- Baby AT Case
- 5 ISA & 2 VESA®/ISA Slots
- AnyKey® Keyboard & MS Mouse
- MS-DOS® 6.2 & WFW™ 3.11
- Choice of Application Software
- EPA Energy Star Compliant

$1495

4DX2-50 FAMILY PC

- Intel 50MHz 486DX2 CPU
- 8MB RAM, 128KB Cache
- 212MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- Double-Speed CD-ROM, 16-Bit Sound Card & Speakers
- 2400/9600 Data/Fax Modem
- 3.5" Diskette Drive
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 101-Key Keyboard, MS Mouse & Joystick
- Choice of Family PC Software
- EPA Energy Star Compliant

$1995

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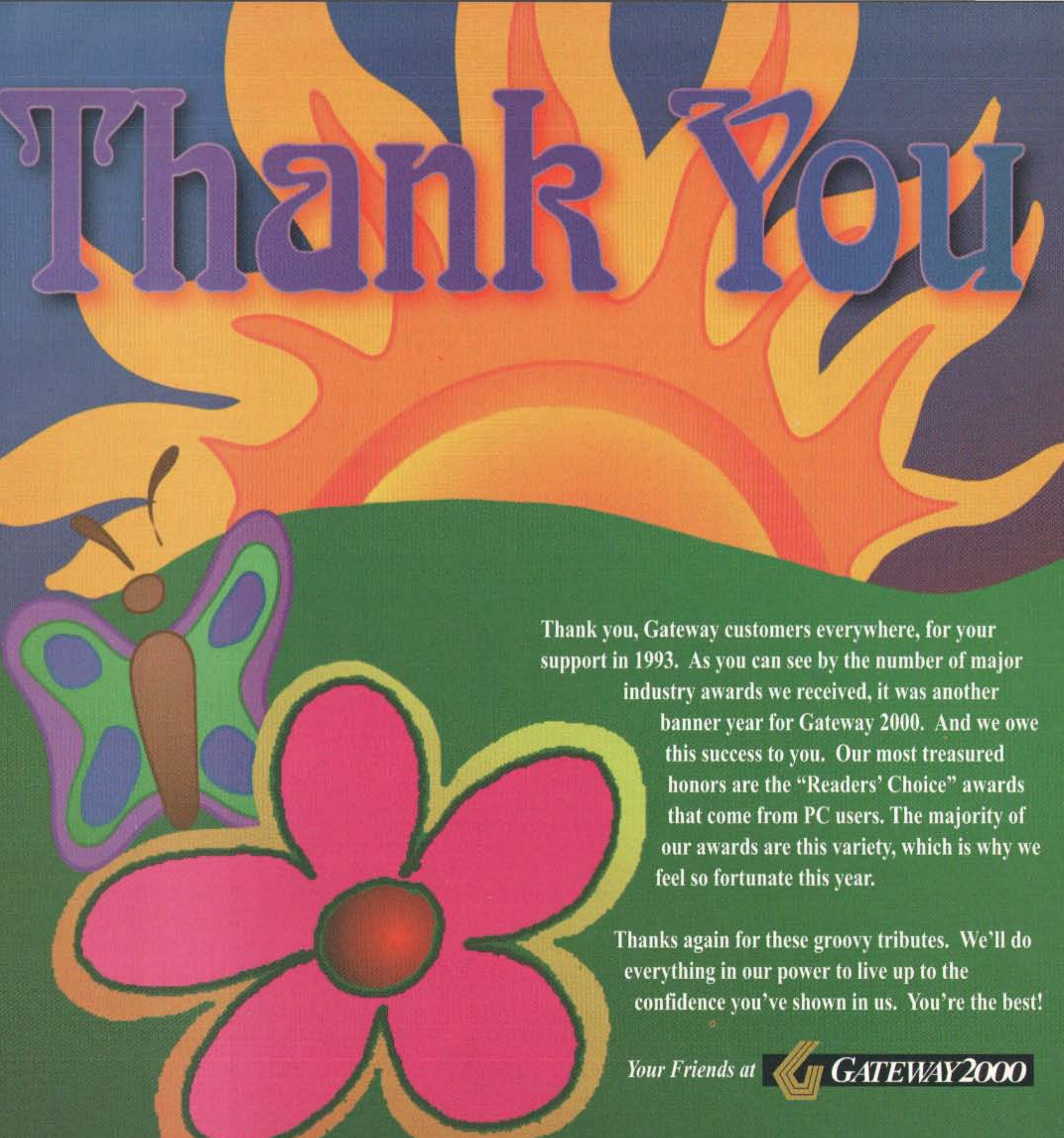

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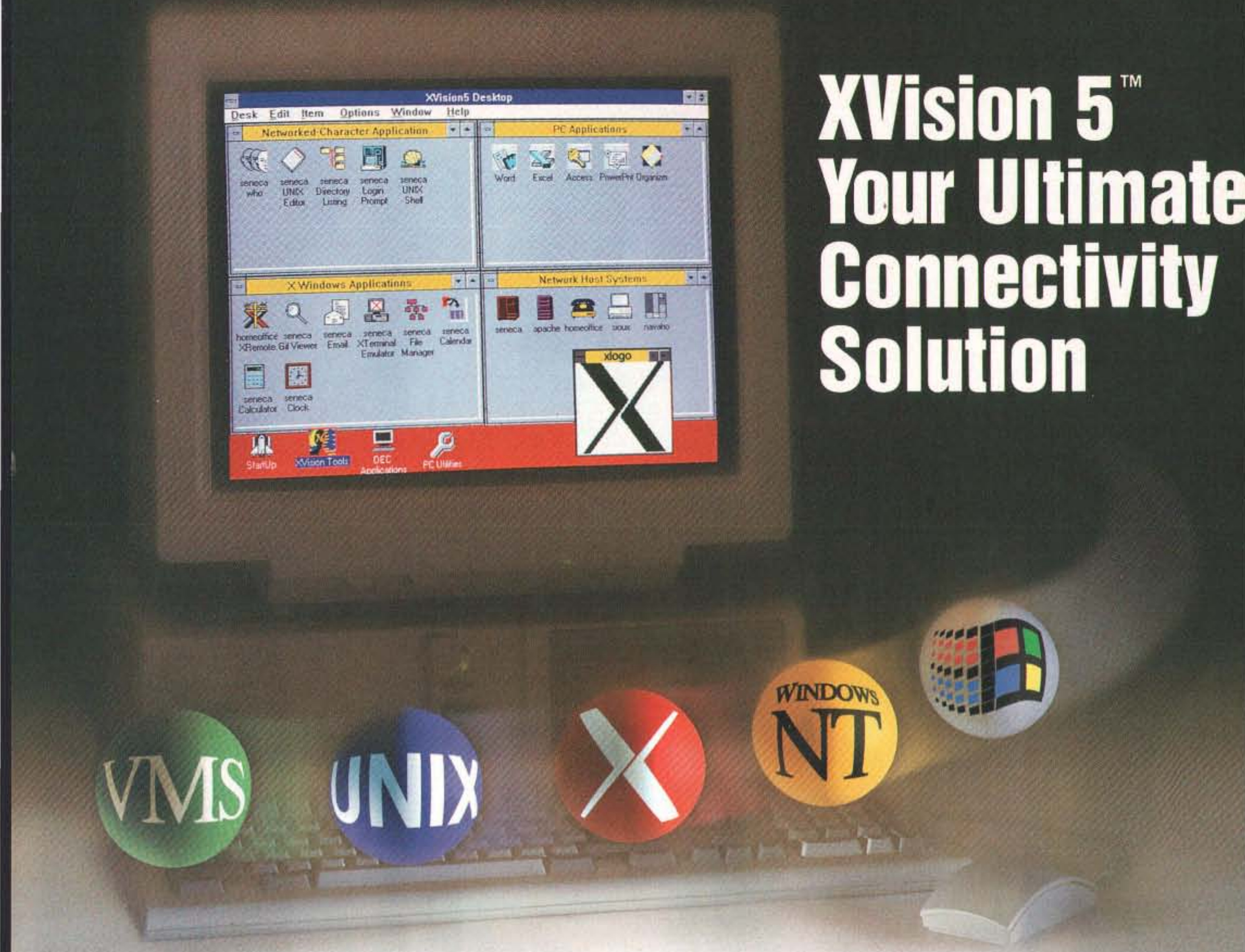

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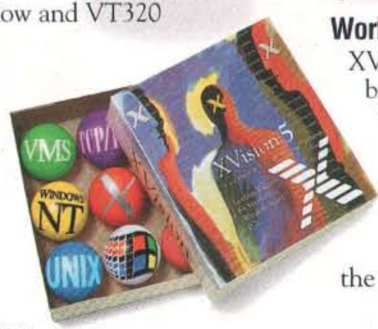

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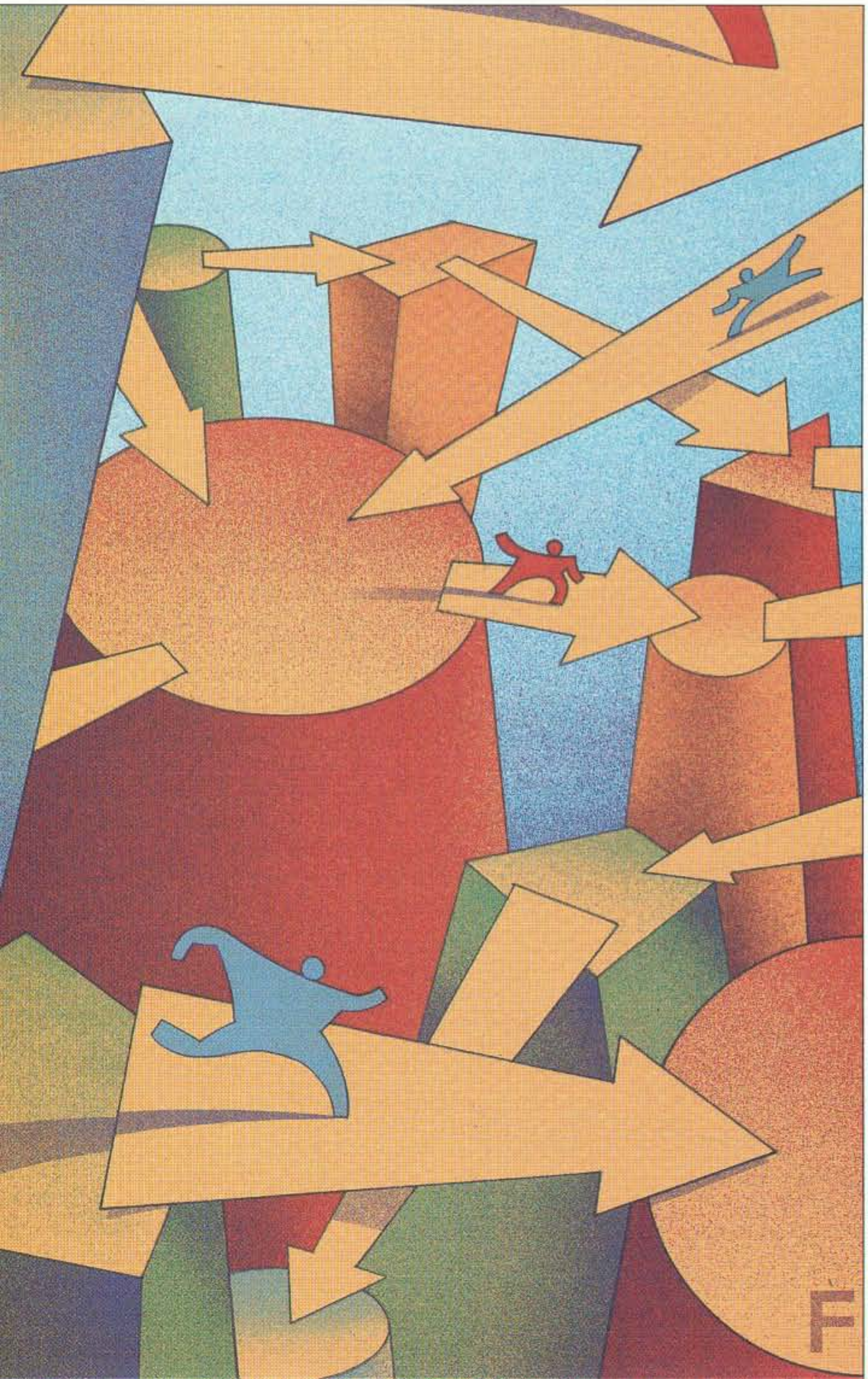
DEVELOPING FOR MULTIPLE PLATFORMS

Businesses expect software to run on Macintosh, DOS, Windows, and Unix. Moving an application to another platform is a daunting task that can change a developer's approach to writing software.

DOUGLAS K. OLSON



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Businesses today expect the same applications to be available for Windows, DOS, and Macintosh computers. Consequently, engineers are finding ways to sustain and codify cross-platform development efforts. Their strategies are varied, and the process remains highly subjective, but new tools and techniques are gradually beginning to speed and simplify cross-platform development.

One simplification has come with ANSI C and C++, which freed developers from compiler-specific design. By adhering to ANSI C syntax, for example, developers can create code that comes closer than ever before to being compatible with compilers for multiple platforms. In effect, applications are moving toward real portability.

Toward Compiler Independence

Many issues still stand in the way of compiler independence. For one thing, despite the ANSI standard, various compilers interpret C syntax differently. The reality is that developers must still write C code for specific, individual compilers.

For example, ANSI C does not define the size of all data types. Integer size can be either 16 or 32 bits—whichever is optimal for a given platform. Developers often make the mistake of depending on the size of this variable in their code. And compilers on the same platform implement this data type differently.

Developers also need to be aware of processor-based restrictions. For example, compilers must align data structures on short- or long-word boundaries, according to the memory-addressing rules of various processors. Trouble can result when code makes different assumptions about such alignment.

Platform conventions also define compilers. For example, the Mac environment groups and identifies resources by four-character constants, such as ICON for an icon resource or PICT for a picture resource. Most Mac compilers let you assign these four-character constants to 32-bit

Porting Adobe Photoshop: A Case Study

In the course of developing and porting Adobe Photoshop, a package for editing images, Adobe engineers have learned a number of lessons.

When Photoshop was conceived in 1988, the Mac was the only affordable desktop system with the needed horsepower. Adobe developed the application in MacApp, an object-oriented framework using Object Pascal. At that time, Windows was not a significant factor for graphics applications, and the Mac was clearly the platform of choice for graphics and desktop publishing.

By late 1990, it was clear that the Windows platform would become a major market, and Adobe began planning its first Windows port. The company faced a difficult task. Understandably, it had not taken enough of the precautionary and preparatory steps that are routine today. Adobe had created a base of source code for which there were very few tools. Windows compilers existed for C, C++, and Pascal, but not for Object Pascal, which was little known outside of Apple.

Doug Olson (lower left) with Adobe Photoshop team members.

MacApp itself presented a serious porting challenge. To port Photoshop, not only the application code would have to move but also the entire MacApp framework.

While planning this first Windows port, Adobe was also mapping out new features for the next major upgrade. Clearly, if Adobe engineers opted to take a "snapshot" of the existing Photoshop code and then embark on a complex port to Windows while simultaneously bringing major new features to the Mac side, the two versions would be hopelessly out of sync.

Still, market conditions favored the snapshot approach. No one was certain that Windows would become a popular, viable platform for graphics and desktop publishing software. And it seemed unwise to tie up the highly successful Mac version of Photoshop while engineers reworked the application to sustain future cross-platform development efforts.

EMULATING MACAPP

In the end, Adobe opted for a sustained approach, hoping to avoid an endless pattern of releasing different platform versions with leapfrogging feature sets. Adobe decided to do a bulk translation of Photoshop from Object Pascal to C++ and to restructure the application into separate core and edge code. It would also create its own framework for Windows that emulated MacApp.

The first step was to form separate Mac and Windows development teams. Engineers on the Mac side would restructure the product to separate core code and API-related code. They would use MacApp 3.0, written in C++. Their goal was not to port code but to structure it properly. At the same time, the Mac team was working on new features for the next major revision.

Meanwhile, the Windows team began building an emulation of MacApp. They looked at the existing Photoshop and emulated only the required portions of MacApp—those relating to the user interface. Their goal was to bring MacApp functionality to Windows and thus ensure that Mac code would compile under Windows.

At that time, it was unclear whether the Windows team would be licensed to use MacApp source code, so they worked without it, using headers that described the MacApp API and building their own analogs. As a result of their efforts, it is possible, using emulated portions of MacApp, to translate the Mac GUI into a Windows GUI. Adobe developed its own tool that converts Mac *view resources*—which describe interface elements such as dialog boxes and buttons—for use by the emulated MacApp.

This effort was so successful that, to this day, as Adobe's developers continue to improve Photoshop, their code for new features usually compiles without modification under either platform. Aside from the usual compiler independence issues, little hampers this process. Now, when developers complete new Photoshop features for either platform, the same features can be running on the other platform in short order. Mac and Windows versions of Photoshop ship within weeks of each other.

NEW PLATFORMS—UNIX, POWERPC, AND NT

Encouraged by the successful Windows port and market forces, Adobe decided to develop Unix versions of Photoshop, including Sun Microsystems and Silicon Graphics. By leveraging fast I/O bandwidth and RISC processors, Photoshop will get a big performance boost.

To bring Photoshop to Unix platforms, Adobe is using Latitude, an emulated API system from Quorum Software Systems. Because the Quorum system emulates the Macintosh API, MacApp ported directly. A high percentage of Photoshop's Mac source code, running against Latitude's Unix libraries, has compiled without change.

Adobe is currently porting Photoshop to the PowerPC Mac and Windows NT. While it is too early to discuss either port in much detail, the basic approaches are clear.

In porting Photoshop to the PowerPC, the quirks of MacApp proved to be the major obstacle. Apple's compilers for the PowerPC, which were written by IBM, were not geared to certain

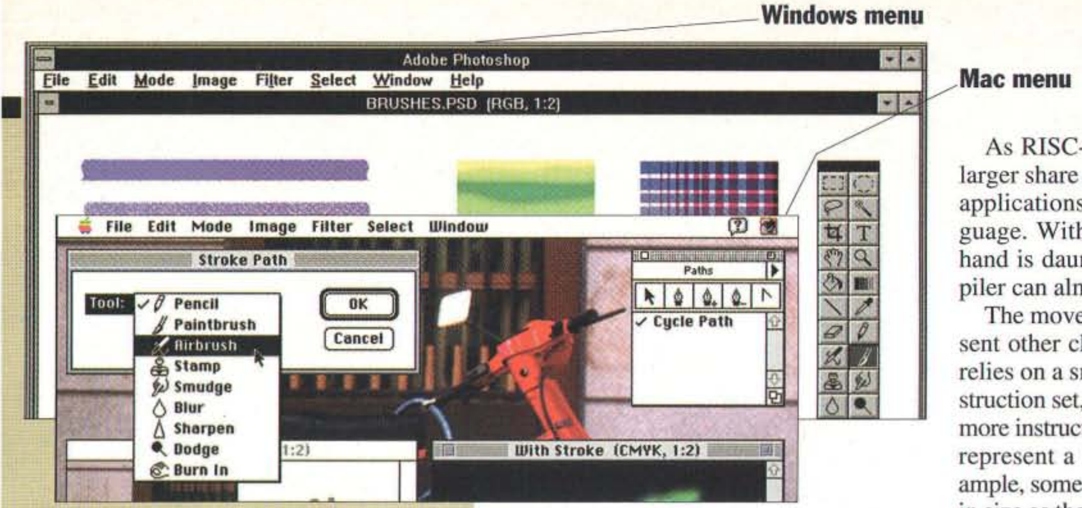
variables. But this is not strictly legal ANSI C behavior and will fail on platforms that don't observe this convention.

The ANSI standard offers a mechanism for deviating from its imposed uniformity. For example, to tell a compiler to generate code for a specific processor, developers use `#pragmas`, C words that govern platform- and compiler-specific directives.

When groups of people program together, source code management tools are essential. The danger is that two people will modify the same code at the same time, destroying each other's changes. Also, it is often necessary to track code changes and store iterations. Unfortunately, until recently, most vendors of version-control software built their products for one line of platforms.

One common solution is to establish a system that acts as a neutral third party. For example, teams targeting Windows and the Mac could choose a source code control package on a Unix machine. Another strategy is to standardize on a version-control system for a given platform, such as Projector, part of the MPW. Here, the entire cross-platform team would have access to Mac machines and would check their code in and out of the Mac.

This picture is changing as vendors design source code management products for multiple platforms. One Tree Software's (Raleigh, NC) SourceSafe maintains compatible tools and source code database files that run on the Mac, Windows, and Unix. Intersolv's (Rockville, MD) PVCS Version Manager is a version-control product for Windows, NT, DOS, OS/2, and Unix.



The screens show how well the Windows and Mac versions of Photoshop correspond.

peculiarities of Object Pascal. For example, one involves the use of objects based on handles rather than pointers—a distinctive aspect of Macintosh memory management. Supporting such Object Pascal–based objects and calling sequences was too much for the PowerPC compiler. To get around this, Adobe and Apple jointly developed a new version of MacApp that compiles under PowerPC.

PowerPC and NT bring important changes to APIs and raise the usual issues of compiler independence. With NT, for example, the target machine may be using any of a number of different processors from Intel, Mips, and DEC.

NT brings important benefits to applications like Photoshop. For example, image-processing applications need large data structures. To run under Windows, these had to be broken into 64-KB units—a requirement that NT eliminates because it relies on a 32-bit flat-memory model, just like the Mac. Thus, NT removes the performance constraints that compromise the performance of Photoshop under Windows.

It turns out that, with the MacApp emulation well established on the Windows side, the Photoshop Windows source code contains no attributes that do not easily compile. Therefore, the Adobe team was able to move Photoshop easily to NT.

Debugging is an inherently low-level, platform-dependent task. Now, no debuggers work the same way or present the same interface from platform to platform. The idiosyncratic nature of debuggers makes it a challenge for developers to acquire expertise in more than one platform.

Object-oriented frameworks, such as Apple's MacApp and Microsoft's Foundation Classes, provide a generic application to which developers need only add specific behavior. For example, MacApp has a class library that implements a standard Mac application—it handles menu commands, updates windows, dispatches events, deals with the Clipboard, and so on. The class library handles all the general items, and the developer provides the application-specific behavior.

Such frameworks can be a boon to development but, unless they target multiple platforms, can seriously hamper future ports. For example, Adobe originally developed Photoshop for the Mac using the MacApp framework and then decided to port the product to Windows. There was no abstracted, portable API into MacApp—and certainly no corresponding Windows version—so developers faced an unusual challenge (see the text box "Porting Adobe Photoshop: A Case Study").

Code Issues

To gain performance, virtually all commercial developers write key portions of application code in assembly language. By hand-assembling performance-sensitive components, the developer will generate more efficient code than the compiler and selectively give a boost to important operations. For example, painting with a mouse in a Photoshop document is a well-defined, highly performance-sensitive task. Because Adobe didn't want to compromise performance here, it wrote the inner loops of that function in assembly language.

The problem is that processor-specific assembly code is inherently not portable; to facilitate the porting process, developers have learned to maintain high-level language analogs of assembly language components. Now, when developers rewrite critical C code in assembly, they retain the original C code as well. With these C analogs, engineers can quickly move a package from one platform to the next. They can get a C version running on the new platform and only then decide whether to again rewrite specific sections of code in the new platform's assembler.

As RISC-based systems account for a larger share of the desktop market, future applications will use less assembly language. With RISC, assembling code by hand is dauntingly complex, and a compiler can almost always do a better job.

The move to RISC processors will present other challenges as well. Because it relies on a small and relatively simple instruction set, a RISC machine needs many more instructions than a CISC processor to represent a high-level function. For example, some Mac applications may double in size as they move from 680x0- to PowerPC-based platforms.

Like a Family Reunion

Historically, porting strategies can be compared to certain aspects of a family reunion. A defining moment of either is a family portrait—a snapshot documenting the state of application code for a particular platform at a given moment. In a real family, once the photo has been taken, members begin to move around; similarly, having recorded the code at an instant in time, developers begin changing it.

On the one hand, the application code for the original platform is modified as it is maintained and upgraded. At the same time, another team of developers is migrating the code, as recorded in the snapshot, to a new platform. So at a definable instant in time, one set of code begins heading in two directions, changing in various ways for different reasons.

Typically, once the port is completed, developers return to the first platform and begin planning the next major revision. But what should they upgrade? The original snapshot version has changed a lot, and in porting to the second platform, developers invariably add new features and functions. So where do developers start?

The usual answer lies in the family reunion. The latest versions for both platforms must somehow be reunited and reconciled to provide a basis for the revision. Like family members who have not seen one another for many years, the two sets of code do not easily recombine. Developers do their best to re-create a common code base that incorporates desirable features from both versions. But this process can become so difficult that it is often easier to port just the application in reverse order, from the second platform to the first.

Virtual APIs

One improvement over the family-snapshot approach is to emulate the original platform's API on the new platform. This is the next logical evolutionary step in development strategy.

Products are offering these emulated APIs and cross-platform code libraries. Examples are Quorum Software Systems' (Menlo Park, CA) Latitude, a Mac-to-Unix product, and Altura Software's (Pacific Grove, CA) Mac2Win, a Mac-to-Windows product. In theory, about 80 percent of the source code in a standard high-level language should compile.

However, emulated APIs and their libraries invariably trade performance for speed of development. One problem is that different APIs do not map precisely to one another. The extra code required to compile disparate operations from one graphics model to another can significantly slow application performance. One answer is to write platform-specific code here, reaching through the emulation and writing directly to the target API. This effectively trades portability for efficiency.

One way around fundamental differences is to create a virtual API that represents no single platform but embraces standard functions of many. This generic API runs on many platform APIs. When a developer builds a window, for example, this virtual API would call `NewWindow()` on the Mac side and `CreateWindow()` on the Windows side. One commercial product of this type is XVT (Extendable Virtual Toolkit) from XVT Software (Boulder, CO).

Unfortunately, these generic APIs often produce bland software. Such applications are unlikely to consistently leverage Windows or Mac GUIs in ways that users like. For this reason, virtual APIs are less attractive to commercial developers. These APIs are more practical for, say, vertical-market software developers or MIS departments that need to target an in-house application to multiple systems.

Successful Approaches

Today, one popular way to speed the porting process is to separate *core* code from *edge* code. Core code includes the basic operations that are common across all platforms. A spreadsheet performs calculations and manages data in cells; a word processor formats text; and image-processing software blurs and sharpens—these operations run more or less the same on all platforms. Edge code includes those parts of a program that deal with platform-specific issues, such as human-interface functions.

Engineering platform-independent code in one large effort and optimizing platform specifics in parallel, smaller efforts produces major efficiencies. This approach is popular with many commercial developers because it does not compromise the product's "platform flavor." Microsoft estimated that 90 percent of the then-unreleased Microsoft Word 6.0 would be based on common code.

Today's most widely used object-oriented development environments take advantage of core-/edge-code separation. One new cross-platform development framework from Borland is OWL (Object Windows Library). Another object-oriented framework, Bedrock, is being developed by Apple and Symantec. Bedrock will give developers a somewhat abstracted API that controls two separate frameworks:

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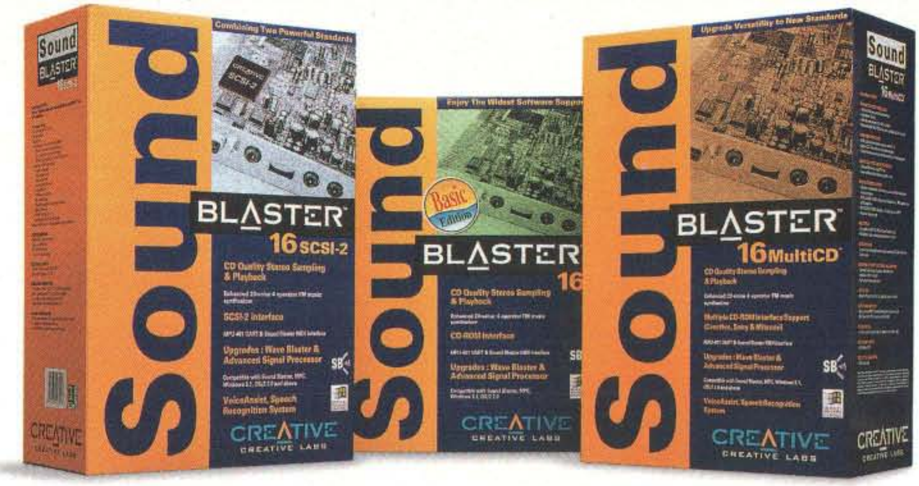
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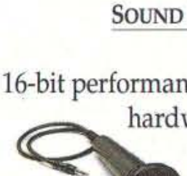

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one for Windows and one for the Mac. This provides some of the benefits of a virtual API while letting developers separately refine edge code for each platform.

Trade-Offs

Today, market realities dictate that major applications must run on all mainstream platforms. Developers are reluctant to invest in technologies and feature sets that exist on only one platform. This is why Microsoft is eager to introduce the newest version of OLE to the Mac, and why Apple has made its QuickTime video technology available to Windows. Developers want to know about a feature's cross-platform potential before they incorporate it.

On the other hand, if developers decide not to target single-platform technologies, their applications tend to reflect the lowest common denominator. Such software may be workgroup-friendly, but if it lacks platform flavor, it can disappoint individual customers. Developers face an ongoing challenge to maintain a balance of features between platforms without compromising the unique flavor of each.

Developers must also decide just how much alike the same application should look on different platforms. They know that users tend to have a favorite platform and expect applications to reflect certain platform characteristics. Again, in striving for middle-of-the-road commonality, an application can fail to leverage the best attributes of either platform.

A related issue is the timing of releases. However methodical and even-handed engineers try to be in cross-platform development, they usually favor one platform over another, so the second version tends to lag. A company determined to release versions for different platforms at the same time invariably compromises performance, features, or time-to-market in one version.

Managing cross-platform development teams involves different trade-offs. The challenge is to sustain work on two platforms, while challenging the imaginations of all developers. It's important to ensure that no one team gets stuck with too much drudgery for too long. One solution is to assign platform experts to developing edge code and put generalists to work on core code. Another is to have one team working on new features for one platform, while a different team ports a "snapshot" from that first platform to a second.

This latter approach can be effective in bringing software to market, but it really isn't sustainable for long, because it fails to efficiently leverage the teams' overall effort. This means products will be slow to market, and companies will incur high engineering expenses.

Here to Stay

New operating systems are becoming increasingly portable. Users will soon be able to choose hardware and system software independently of each other. As a consequence, cross-platform development is here to stay. For developers, the ability to write portable code using techniques such as core-/edge-code segregation and object-oriented methodologies is becoming a key competitive advantage. ■

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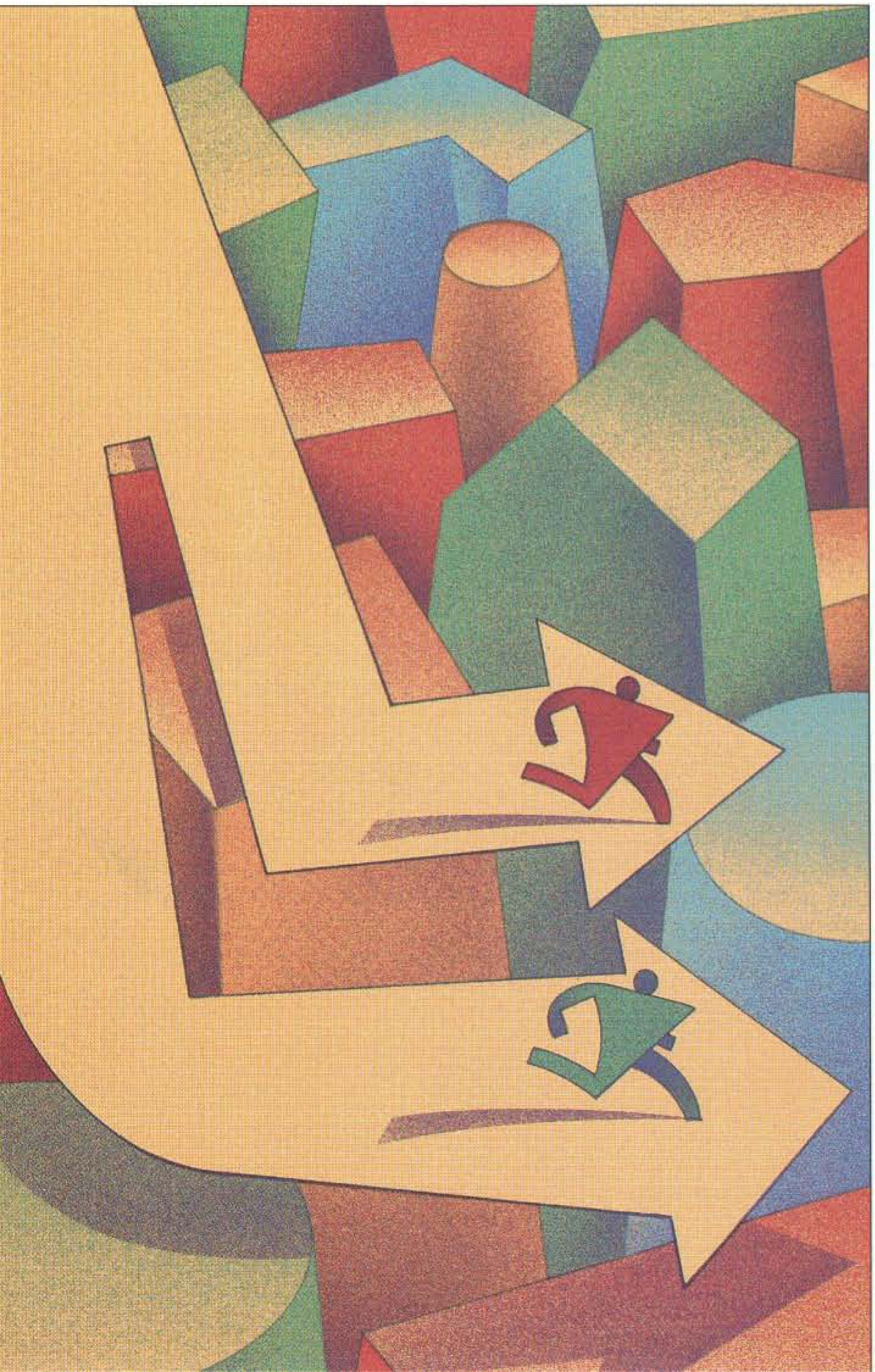
COMPILERS FOR PARALLEL CPUS

New computers using multiple CPUs may increase throughput considerably—providing the compiler understands how to build code for the specific machine

OLIVER SHARP



MARK FISHER ©1994

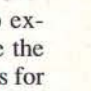
Two heads are better than one—or at least they can be. With this in mind, computer designers and programmers have long sought to harness processors together so that time-consuming applications will execute faster. During the past few decades, researchers and manufacturers have created wildly different parallel-processing architectures. This has kept life interesting for applications developers, who must learn how to use the new machines. The primary burden, however, falls on systems developers and compiler makers to create tools that exploit the new capabilities.

Four main types of parallel machines are VLIW (very long instruction word), distributed-memory, shared-memory, and data-parallel (see the text box "Types of Parallel Machines"). Each type has its own set of implications for compiler design and use.

A variety of programming models have been proposed for building parallel applications. In some cases, the programmer does all the hard work, while in others, the compiler is responsible. Some models leave the parallelism exposed and obvious, some force the programmer to express it manually, and others require the compiler to dig it out. The same holds for scheduling onto the available processors.

Dusty Deck Model

The simplest solution is the dusty deck model, the one programmers like best. It provides a `-parallel` option on the compiler. If you feed an existing program through the compiler, efficient code pops out for your parallel machine. This idea is the holy grail of parallel compilation and has been enthusiastically pursued by the research community. Unfortunately, the results have not been encouraging. (The term *dusty deck* is a rueful homage to the thousands of huge, time-consuming applications, written on punched cards in

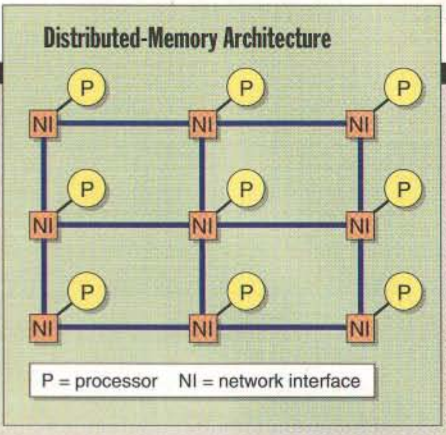


Types of Parallel Machines

DISTRIBUTED-MEMORY ARCHITECTURE

A computer network is one form of distributed-memory machine. A better approach uses a single box for up to 1000 processors, with hardware for fast communication. Key issues include bandwidth, latency, topology, network interface, and communications/computation overlap.

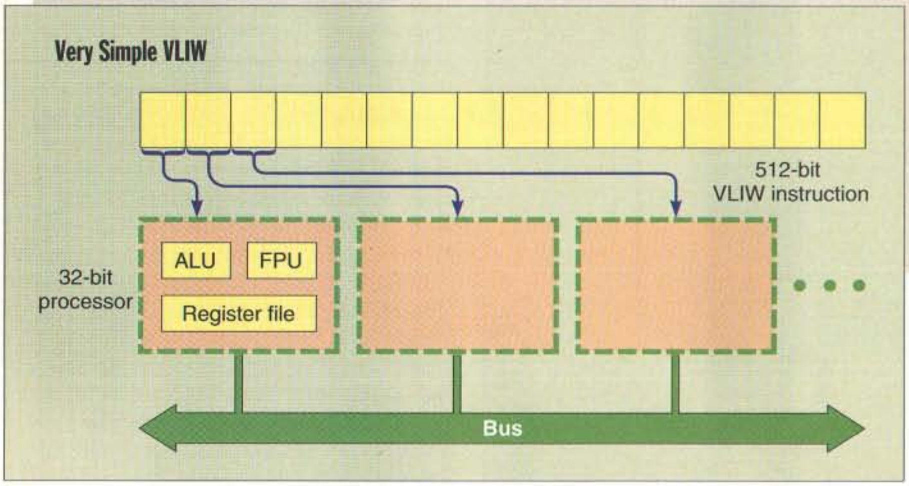
This is the most popular approach. Thinking Machines' CM5 Connection Machine has a network of SPARC processors that can theoretically yield 100-plus MFLOPS performance. Others include the Cray T3D, with DEC Alpha processors, and the Intel Paragon, with 860s.



Distributed-Memory Architecture

VLIW MACHINES

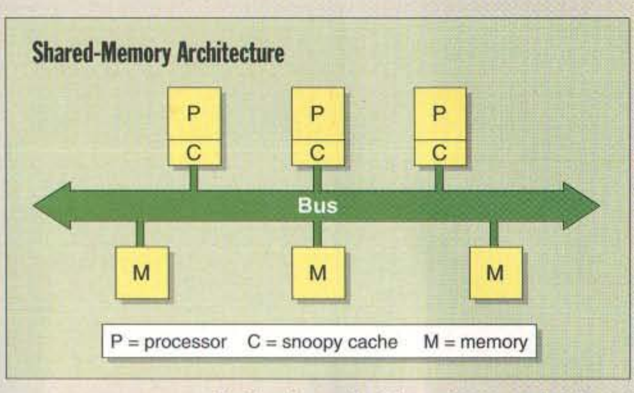
VLIW (very long instruction word) machines have many functional units (e.g., floating-point adders and multipliers). Where superscalar chips have a couple of these units, VLIW machines have dozens. Each instruction can have up to 1024 bits, with many small subfields that tell a unit what to do. It's up to the compiler to keep all the units busy. Multiflow Computer built and marketed a major VLIW design in 1988. The company developed many interesting compiler techniques, but it went out of business in 1991.



Very Simple VLIW

SHARED-MEMORY ARCHITECTURE

Attaching all processors and memory to a shared bus creates a single address space. Memory location 1000 on each CPU refers to the same piece of storage. Programmers don't need to send data between CPUs.



Shared-Memory Architecture

Caching is required for performance, but intelligent caches are needed to work correctly. Consider the following example: Processor A reads a memory location and caches the data; processor B writes a new value to that same location. "Snoopy" caches, which monitor the bus, keep A from using the outdated value.

Adding processors means you eventually run

languages such as FORTRAN, which have been running for decades.)

Recompiling these dusty decks is hard because it is difficult to figure out what they do, how to transform them, and how to decompose them for good parallel performance. Before the compiler can exploit parallelism, it needs to know how the existing code behaves. This is a major problem with most languages now in use. It's easy to translate array operations into correct executable code but much harder to summarize array behavior at a higher level.

In a complicated loop, for example, the compiler is faced with dozens of lines of code that invoke procedures, walk over arrays, and jump around unpredictably. What data does each iteration touch? Could iterations be executed in parallel? How balanced is the cost of execution across iterations? These are hard questions to answer.

Nor is it enough to just understand the code as it stands. Anyone who has "parallelized" applications knows that good performance usually requires changing the code's behavior. Some parts must be recoded entirely, data structures modified, or array traversal changed. And compilers aren't good at any of those tasks.

Even after you have fully analyzed and transformed a program, you aren't done. You must still decompose operations for the parallel architecture, making scheduling decisions and embedding them into the executable file (see the text box "Converting an Application for Parallel Processing"). The conversion requires the programmer, the compiler, or both to make a lot of nontrivial decisions about how to break up the problem.

Although the fully automatic approach hasn't worked well, researchers have developed many systems for interactively analyzing, transforming, and decomposing sequential applications. These make the task less onerous but are far from being turnkey solutions that shield the programmer from the complexities of parallelism.

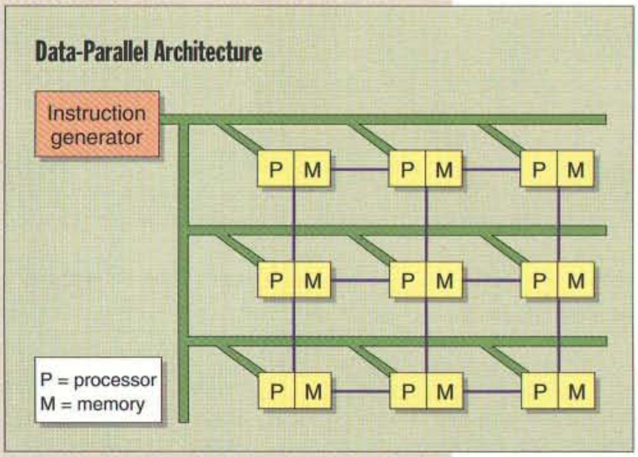
Message-Passing Libraries

Message-passing libraries move you from one extreme to the other. With them, you forget the compiler and manage the parallelism yourself. Most applications that run on distributed-memory machines today use message-

out of bandwidth, so shared memory has lost popularity except for speedy desktop machines. Newer operating systems—including OS/2 and Windows NT—are being extended to support a few processors. Most shared-memory machines to date (e.g., the Sequent) run Unix.

DATA-PARALLEL ARCHITECTURE

This unusual machine has many small, limited processors that work together in lockstep. A central unit broadcasts a command to each, and they all execute together. The best-known data-parallel machine is the 1987-vintage, 64,000-processor CM2 from Thinking Machines.


Data-Parallel Architecture

passing libraries that give the programmer full control over decomposition and scheduling. These libraries provide routines to distribute tasks to processors and send data back and forth across the machine. Some libraries support features such as asynchronous communication; you hand them a callback routine that will be invoked the next time a message arrives.

The compiler doesn't do much with these kinds of applications; they are treated like ordinary sequential programs. Writing an application using message passing is like programming in assembly language; you get control of the system whether or not you want it. You also spend much time manually shipping data around the system.

Debugging becomes a terrible job. A program's behavior can change every time it runs. Worse, many bugs depend on timing. If a message arrived in time, the program reads correct data; if not, you get garbage. Also, the bug may occur on some runs but not others. Adding debugging code can change the timing enough to mask it. If you take the test code out, the bug reappears; this can be maddening.

The Shared-Memory Model

The shared-memory model is the usual way to program a shared-memory machine. A copy of your executable file runs on each processor; all share the same data. They communicate with one another the same way multiple threads do; they can set or release locks or use semaphores.

A "bag of tasks" is a simple strategy that's easy to code with the shared-memory model. Divide the work into separate tasks and put the tasks into a bag, or a list. The different processors draw work from the list; when one processor finishes a task, it picks up another from the list. To access the list safely, you must use a semaphore to request exclusive access. When the request returns, you own the list and can remove the first item on it. You release the lock and start on the task.

The advantage to this model is that the programmer doesn't have to move data. Just by referring to a memory location, you arrange for the data to be available to your processor. But don't ignore locality; even on a shared-memory architecture, there is a cost to data transfer, and you get poor performance if you don't pay attention to it.

Debugging is easier on a shared-memory model, because data is immediately accessible, and programs are less cluttered with explicit communication routines. Still, timing-dependent behavior is a serious problem.

As with message-passing libraries, the compiler usually doesn't help much. The programmer has to assign work to processors and manage the interactions, although the code is more compact than for a distributed-memory application. Some researchers have looked at using compiler transformations to improve performance; the problem is related to cache management on a sequential machine.

While this model is most commonly available on shared-memory machines, an ambitious goal is to supply it on other architectures. Here, the compiler becomes an integral player because a simple-minded implementation would yield dismal performance.

Hints from the Programmer

This method lets the programmer help the compiler. That's the idea behind a number of recent languages, including FORTRAN D, which provides keywords that let the programmer specify how to allocate data across a parallel machine.

Every processor gets a copy of the program and execute it together. Based on the programmer's directives, a processor *owns* some of the data. On a four-processor machine, for example, each CPU might own every fourth column of a large matrix.

As the program executes, the system decides which processor performs each computation according to the "owner-computes" rule. When the value of a computation is assigned to a specific memory location, that location's owner performs the operation. Other processors must send any required data to the location's owner.

Now under construction, the FORTRAN D compiler faces the hard task of minimizing communications overhead. A modern processor can execute a floating-point operation in a tenth of a microsecond, but a message between processors takes much longer—tens or hundreds of microseconds. It is impractical for each instruction to wait for a message to provide data. The solution is for the compiler to look at a block of code (typically a loop) and know beforehand what data each owner will require. Before the application starts executing that code block, it arranges for each processor to make a bundle of data and send it to the owners that need it. Each owner can perform its computations without further communication. Because the programmer can easily produce code that is hard to analyze, the FORTRAN D user must learn to write programs the compiler can handle effectively.

Data-Parallel Programming Model

The data-parallel programming model provides the programmer with primitive operations that can be applied to an entire set of data at once. By composing these operations, you can perform complex and powerful manipulations of large

Converting an Application for Parallel Processing

Imagine that you are trying to implement a simple climate model on a distributed-memory parallel machine. There is no need to describe climate modeling in detail here; you can look at parallelization without understanding much about the physics being modeled. This example outlines a simple-minded approach to the problem and explains why it may or may not perform well.

Master/Slave Parallel Processing

```
master_code()
{
  /* setup */
  start up one slave per slave processor
  broadcast to each slave processor the grid squares it will
    handle
  distribute initial data to each slave

  /* start modeling */
  for i = 1 to max_timesteps
    call slave_code() ;tell each slave to compute one timestep
    wait until slaves finish and report results
    compute and store summary information from the results

  tell each slave to die
}
slave_code()
{
  /*  setup  */
  wait for master to say which grid squares to handle
  wait for initial data

  /*  start modeling  */
  do forever:
    get message from host
    if asked to die, commit suicide
    compute_timestep()
    send local-state info to host
}
compute_timestep() {
  send interaction information to each neighbor
  wait until each neighbor's information arrives
  model physics in each grid square, using neighbor info
}
```

Creating the Model

First, divide up the earth's surface using a 2-D grid. Each grid "square" represents, say, 5 degrees of latitude and 9 degrees of longitude, giving a total of 1440 grid locations covering the earth. (They aren't actually squares, of course.) The model will track various parameters for each square: water vapor, temperature, radiation absorption, and the amount of sunlight reflected by the surface. (This simplified model might bother a real climate researcher, because their 2-D models usually divide the earth into latitudinal bands and the atmosphere into vertical layers.)

In this model, each iteration corresponds to a given amount of simulated time—say one hour—and consists of two steps. First, neighboring grid squares exchange information. A hot square might leak some of its heat to a cooler neighbor, or perhaps wind currents lead to the movement of water vapor between squares. Then, after each square gets the information it needs from its neighbors, you have the system figure out what happens within the square and update its local state. To keep track of what the model is doing, various summary results for each iteration are computed and stored; you can view those results after the program finishes to find out what happened.

Analyzing the Parallel Possibilities

The first step in parallelizing the model is to figure out how to decompose the problem. This application, like many physical models, has good locality—a grid square directly influences its neighbors, not squares on the other side of the world. To take advantage of that property when decomposing the application onto different processors, you allocate contiguous blocks of grid squares. If you chose instead to allocate individual squares randomly, this would introduce much more communication when the squares tried to talk to their neighbors.

This example uses a simple parallel architecture with a master host processor that controls 16 slave processors. The costs are about equal for communicating between any pair of processors. The listing "Master/Slave Parallel Processing" shows how the application might be structured on such a machine. So how much faster will this application run on 16 processors rather than on just one? That depends.

Your biggest ally is locality; the "area-perimeter" rule says that if you only communicate at the edges of a rectangle, the ratio of communication to computation improves as the rectangle gets bigger. That's because the amount of data sent is proportional to the length of the perimeter ($2*A + 2*B$ for an A by B rectangle), while the amount of work grows proportionally to the area ($A*B$). You divided the problem up into a single region per processor, so the rectangles are the largest possible size for your machine.

On the other hand, three problems might trip you up. The first is the cost of communicating between processors. Suppose it takes 1 second for every processor to exchange data with the processors handling neighboring grid points. Ideally, the cost of computing a timestep will be much more than a second. If it were exactly 1 second, you spend only half your time doing useful work. If it takes one-fifteenth of a second, then even if all host-slave communication is free, the 16 processors working together won't go any faster than just one processor acting alone.

The second potential problem is that control is centralized at the host processor. The slave processors have to wait until the host tells them what to do, and all global processing between timesteps happens on the host while the slaves remain idle. Even if the host is fast enough to keep 16 slaves busy most of the time, that may not remain true when more slave processors are available.

Balancing the Workload

Finally, load-balancing problems can easily cut overall performance in half, or worse. You have allocated an equal number of grid squares to each processor; if each square takes the same amount of time to compute, that was a good decision. Even if they vary a bit, you have many grid squares per processor so that will help even things out. But suppose you have an elaborate strategy for modeling ice; when the temperature is low enough, you spend a lot of time figuring out ice formation, thickness, and the fraction of land covered. Since ice doesn't cover much of the Sahara, a few parts of the world will require a lot of processing for the ice model while others will not need any. The processors that cover the Pacific Ocean or Africa will finish their processing quickly and sit around waiting while the processors handling the poles work on the ice model. This unbalanced load hurts performance.

There are two ways to improve load balance: Do a better static decomposition of the problem, or move to dynamic scheduling. Static means that you divide the problem once at the beginning and never change your mind. You might be able to finesse the problem with ice, because the parts of the world that are covered with it are fairly predictable. Rather than giving each processor the same number of grid squares, you could give the ones managing land near the poles fewer squares. That evens out the load so that there won't be as much variance in the time it takes each processor to finish.

A more elaborate strategy for balancing load requires a much more complicated way to manage parallelism. Dynamic scheduling shuffles grid squares between processors as the application runs; when one processor is getting its squares done much faster than another, some of the work is shifted, so the load evens out. Dynamic scheduling is tricky to implement well, though, and it can lead to a lot of overhead if you are not careful.

amounts of data in a few lines of code. If you are familiar with APL, you have a good idea of what data-parallel programs can look like.

Data parallelism is appealing for many reasons. Since all the parallelism comes from the operations, the application has only one thread of control and is much simpler to debug. Programming languages look similar to their sequential cousins, although they need special features for defining data structures and parallel operations. There is one fly in the ointment, however: You must make sure that your program does most of its computation using data-parallel operations, because the rest of the time, you are just executing sequentially. Most existing applications must be completely redesigned, and many will not adapt well to a data-parallel style.

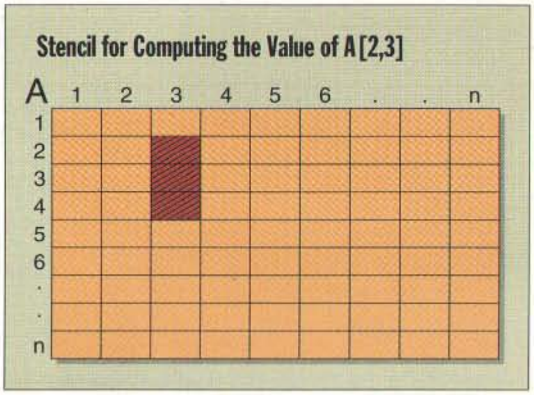
Compiling data-parallel languages can be easy or challenging. If your target machine is data parallel, you can design the language to provide the same primitives as the architecture. Compilation is a snap; you simply translate each data-parallel operation in the program into the corresponding machine-language instruction.

On the other hand, compiling a data-parallel program for a different architecture can be difficult. The figure "Stencil for Computing the Value of A[2,3]" shows a simple data-parallel operation in which each array element is computed based on the value of itself and of the two elements below it. The equivalent in a conventional language would be as follows:

```
for i = 1 to n-2
 for j = 1 to n
  A[i,j]=f(A[i,j], A[i+1,j],
   A[i+2,j])
```

The figure also shows a shaded area representing the data used to compute `A[2,3]`. This data-parallel operation is very regular; the shape of the shaded area will be the same regardless of the array element being computed. The most important task in compiling a data-parallel computation is to figure out that shape, which is called the *stencil.*

Here, the stencil includes no neighbors to the left or right, showing that columns are independent of each other. There is no advantage to allocating two neighboring columns to the same processor. Rows are a different story, however; assigning rows randomly to processors would be an extremely bad allocation strategy.


Stencil for Computing the Value of A[2,3]

An example of a simple data-parallel operation.

The stencil tells the compiler how much communication will be required by any data decomposition. The compiler must minimize communication overhead and balance load. However, compilers can deal with data-parallel models much more easily than conventional programs because the stencil can usually be determined automatically with good accuracy. Languages like FORTRAN often make it very hard (and sometimes impossible) to determine the stencil.

Other Language Models

Conventional languages are hard to analyze for parallelism, and their storage model is mathematically inelegant. Why not toss them out entirely and start over? Many language designers feel that way. One school favors functional languages like Haskell and ML; it is easy to find parallelism in them. Others rely on unification with logic-programming languages inspired by Prolog. So far, none of these alternatives has become widely adopted for parallel programming, but improved implementations in the future may gain converts.

The Future of Parallel Compilation

It isn't easy to produce a program that runs efficiently on a parallel machine. If programming continues unchanged, compilers are unlikely to solve the problem automatically. Researchers will try to help by offering tools that ease the transition; they will also do their best to offer effective new programming models. There's nothing computer scientists like better than designing languages; they won't give up. ■

Oliver Sharp works for Heuristicrats Research in Berkeley, California. He is completing his Ph.D. at the University of California at Berkeley, investigating compilation for parallel architectures. You can reach him on the Internet at oliver@heuristicrat.com or on BIX c/o "editors."

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Advancing Communications

Today's telecommunications software offers high speed, scripting, and even ease of use

HOWARD EGLOWSTEIN

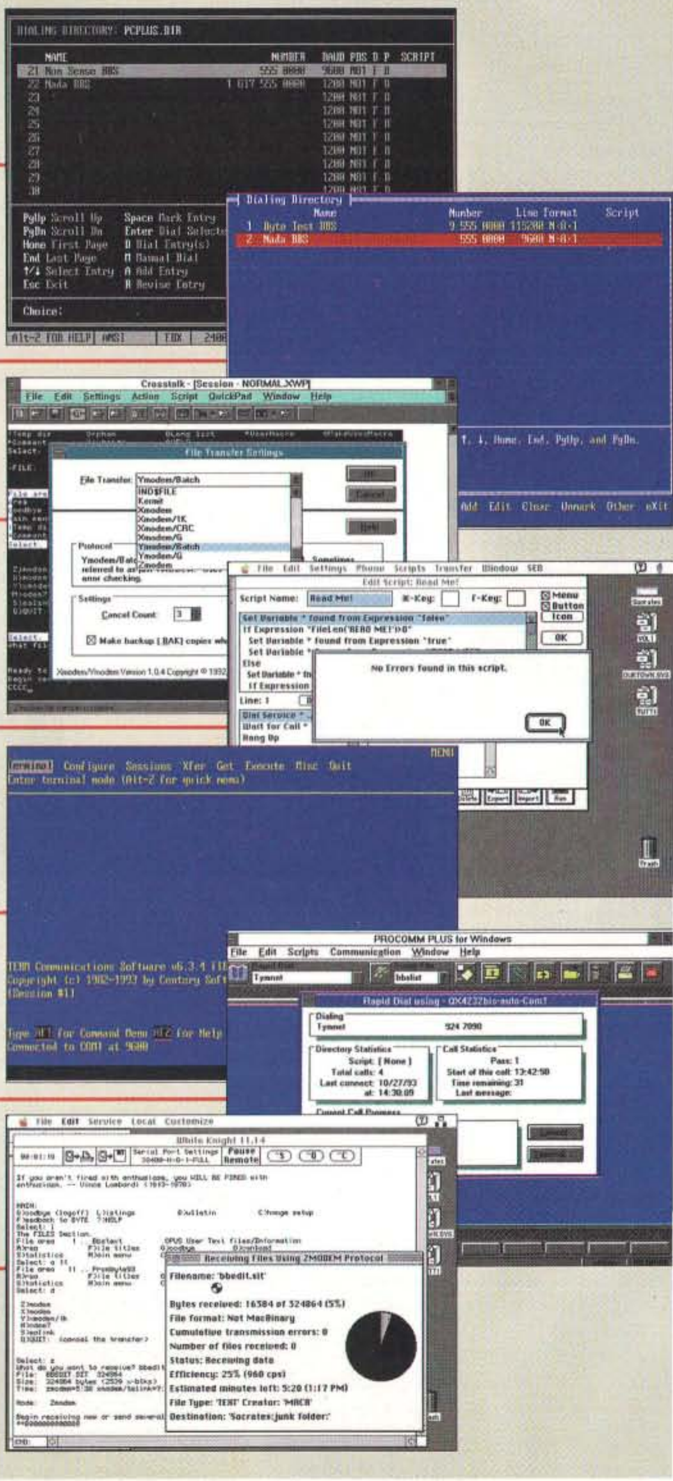
Modern data communications software does lots more than just read E-mail messages. If your current communications package is more than a few years old, you're missing out on all the fun.

Today's advanced communications programs promise speed, features, ease of use, and programmability. The one feature that marks an advanced communications package is, in fact, a strong programming language. That language should be easy to program, yet capable. While it may not make coffee and put out the cat while transferring your files, it should be able to automate many of your communications activities.

In this review I look at seven of the communications packages you're most likely to see on a software store shelf or hear about around the office. There are literally dozens of full-featured communications packages available; I picked these seven because of their overwhelming market presence. According to the sales charts, folks who use MS-DOS communications software are most likely to run Procomm Plus from Datastorm. Due to Procomm's start as a well-liked shareware package, Procomm Plus is far and away the most popular commercial package. Second place belongs to Telix, a shareware application from deltaComm Development.

If you use a Macintosh, you're sure to have heard of MicroPhone Pro from Software Ventures and White Knight from Freesoft. Both of these packages enjoy fierce loyalty from their respective user bases, and rightfully so. Running close behind these two commercial packages is ZTerm, a popular shareware application. I don't look at ZTerm here, but it's available through most Macintosh shareware sources, and it's well worth a test drive.

Given Procomm's popularity on DOS



Procomm Plus's dialing directory lets you pick from 200 prestored numbers. Each number has an associated COM port setting, script file, and usage statistics.

```
DIALING DIRECTORY: PCPLUS.DIR

   NAME                          NUMBER  BAUD PDS D P  SCRIPT
21 Non Sense BBS               555 0000  9600 N81 F 0
22 Mada BBS              1 617 555 0000  1200 N81 F 0
23                                       1200 N81 F 0
24                                       1200 N81 F 0
25                                       1200 N81 F 0
26                                       1200 N81 F 0
27                                       1200 N81 F 0
28                                       1200 N81 F 0
29                                       1200 N81 F 0
30                                       1200 N81 F 0

PgUp Scroll Up      Space Mark Entry
PgDn Scroll Dn      Enter Dial Selecte
Home First Page     D Dial Entry(s)
End Last Page       M Manual Dial
↑/↓ Select Entry    A Add Entry
Esc Exit            R Revise Entry

Choice:
Alt-Z FOR HELP | ANSI | FDX | 240
```

Telix's dialing directory is functionally similar to Procomm's even though it's laid out differently. Like the rest of Telix, the dialing directory clearly shows some heavy Procomm influence.

```
Dialing Directory
     Name                  Number     Line Format    Script
1  Byte Test BBS         9 555 0000 115200 N-8-1
2  Mada BBS                555 0000   9600 N-8-1

↑, ↓, Home, End, PgUp, and PgDn.

Add  Edit  Clear  Unmark  Other  eXit
```

Crosstalk for Windows supports more file transfer protocols than most other packages. Besides those shown here, Crosstalk supports DART, CompuServe B, and Crosstalk. The icons are too small and obscure to be truly useful.

Crosstalk - [Session - NORMAL.XWP]

File Transfer Settings

File Transfer: Ymodem/Batch

IND$FILE
Kermit
Xmodem
Xmodem/1K
Xmodem/CRC
Xmodem/G
Ymodem/Batch
Ymodem/G
Zmodem

Cancel Count: 3

☒ Make backup [.BAK] copies wh

Xmodem/Ymodem Version 1.0.4 Copyright © 1992

MicroPhone Pro comes complete with a handy script editor. You can select functions from a pick list instead of typing them from memory. After you finish writing your script, the editor can check it for errors, saving you lots of debugging time.

Edit Script: Read Me!

Script Name: Read Me!

☒ Menu
☒ Button

Set Variable * found from Expression "false"
If Expression "FileLen('READ ME')>0"
Set Variable * found from Expression "true"
Set Variable *
Else
Set Variable * fr
If Expression

Line: 1

Dial Service *
Wait for Call *
Hang Up

No Errors found in this script.

Term's Spartan interface leaves most of the screen available for your communications session. This screen is from the DOS version 6.3.4, functionally and cosmetically similar to the upcoming Unix version 6.3.

```
Terminal  Configure  Sessions  Xfer  Get  Execute  Misc  Quit          MENU
Enter terminal mode (Alt-Z for quick menu)

TERM Communications Software v6.3.4 (1
Copyright (c) 1982-1993 by Century Soft
(Session #1)

Type Alt for Command Menu Alt-Z for Help
Connected to COM1 at 9600
```

Procomm Plus for Windows is one package that provides a modem status window while making a connection. It's very handy for figuring out why a connection won't go through.

PROCOMM PLUS for Windows

Rapid Dial using - QX4232bis-auto-Conf

Dialing
Tymnet 524 7090

Directory Statistics
Script: [None]
Total calls: 4
Last connect: 10/27/93
at: 14:30:09

Call Statistics
Pass: 1
Start of this call: 13:42:58
Time remaining: 31
Last message:

When White Knight sees an incoming Zmodem transfer, it automatically starts up the file transfer. The efficiency is calculated based on the DTE modem speed (in this case, 38.4 Kbps), not on the carrier speed.

White Knight 11.14

Serial Port Settings 38400-N-8-1-FULL

Receiving Files Using ZMODEM Protocol

Filename: 'bbedit.sit'
Bytes received: 16384 of 324864 (5%)
File format: Not MacBinary
Cumulative transmission errors: 0
Number of files received: 0
Status: Receiving data
Efficiency: 25% (960 cps)
Estimated minutes left: 5:20 (1:17 PM)
File Type: 'TEXT' Creator: 'MACR'
Destination: 'Socrates:junk folder:'

machines, it's not surprising that Procomm Plus for Windows is one of the two big sellers for the Windows environment. The other is Crosstalk for Windows from Digital Communications Associates. DCA used to dominate in the DOS environment as well, but now it appears to have focused more on its Windows product, with good results.

As far as communications is concerned, the Unix crowd doesn't need much more than it already has. Unix installations come with excellent mail systems built in, and many Unix users are content to send mail directly from their machines via the Internet. For transferring files from system to system, Unix is again years ahead of the other platforms with FTP. So how do Unix people access their BIX accounts or dial into a BBS? Usually through public domain implementations of Kermit, but also with Term, a commercial package from Century Software. Term is also available for DOS, Windows, and the Mac. I look at the Unix version here.

Procomm Plus

Procomm Plus is the commercial version of a package that grew up as shareware. The shareware version practically owned the entire DOS market; copies were included free with just about every modem sold. Many users happily upgraded to the commercial version when it became available. Procomm Plus 1.0 had a better scripting language than the shareware version and a much prettier interface. Procomm Plus 2.01 goes it one better.

The Procomm interface is largely based on control-key combinations to implement functions, which makes sense for a keyboard-oriented DOS environment. You can choose to activate Procomm's menu and use it with a mouse, but most users stick with the keyboard.

Procomm's functions are grouped into several primary menus. The setup menu, for example, gives you control over modem settings, file transfer options, and environment features such as "file done" alerts. Other menus include dialing, macros, and hardware setup. Procomm supports serial port speeds of up to 115.2 Kbps on serial ports COM1 through COM8; the I/O addresses and IRQ (interrupt request) settings for all ports are fully configurable.

Like all the other communications software programming languages, Procomm Plus's Aspect is a procedural language. You specify a series of events that must occur in a particular order. The sample Aspect script listing shows a simple script for logging on to the BIX on-line service. Aspect has about 240 commands to do everything from watching a service for specific strings to painting custom dialog boxes on your screen.

However, a communications session often has unpredictable events that can disrupt the flow of a purely procedural language. The ability to handle so-called interrupt events is one feature that separates the good packages from the average. Aspect provides a WHEN statement that lets you define up to three interrupt events for a program to watch for and handle while doing other things.

For example, your on-line service might put out a "..more.." prompt at the end of each page and then wait for you to press the return key. Adding the line `WHEN 0 "..more.." transmit "^M"` anywhere in your script will handle this common situation, sending a carriage return in response to the prompt to provide continuous scrolling.

Surprisingly, Procomm Plus doesn't support devices other than standard 8250/16450 and 16550 UARTs and modems. If you have a networked communication device that works through INT 14 emulation, you'll either have to buy the networked version of Procomm or look elsewhere. Being a DOS package may give Procomm Plus the edge when it comes to performance, but it also means that you can't do background file transfers. If you need this ability, you'll want to either run the package under Windows or some other multitasker, use a Windows program instead, or keep some creaky old 286 system around for doing file transfers.

Telix

Telix grew up at about the same time as the shareware version of Procomm, and it shows: Telix has a look and feel remarkably similar to Procomm's (see the screens on page 104), and many of the function keys do precisely the same things they do in Procomm. I've included Telix here because every DOS communications software user I spoke with either has tried or is currently using Telix. Why? Largely because it's still shareware and it costs only $39 to register.

Telix offers two distinct programming languages, Script Application Language for Telix, or SALT, and Salt Implementation, or SIMPLE. SALT programs look very much like C code. A typical program is a series of IF statements nested within a large WHILE loop. Perhaps I might have gotten into SALT programming more if I was a C programmer, but I found the C syntax unnecessary and the lack of event support (such as Procomm's WHEN statement provides) frustrating.

SIMPLE is a higher-level language that uses an English-like sentence structure to represent many of the SALT functions. The SIMPLE compiler generates SALT code that you can either run directly or modify and compile with the SALT compiler. deltaComm expects you to use SIMPLE largely as a tool to learn SALT; I expect that most Telix users could just use SIMPLE as their primary scripting language.

continued

A sample Aspect script from Procomm Plus that logs onto BIX.

```
proc main
clear                    ; clear screen
locate 0 0               ; locate cursor at 0,0
box 0 0 4 22 14          ; draw box
atsay 2 2 14 "Logging onto BIX..."  ; put message in box
locate 6 0               ; cursor to row 6

if not fromddir          ; if not a linked dial directory script
  dial TYMNET_ENTRY      ; dial TYMNET
endif
transmit "^M"            ; send a carriage return
waitfor "identifier"     ; wait for TYMNET prompt
transmit "A"             ; send an A
waitfor "log in: "       ; wait for TYMNET prompt
transmit "bix^M"         ; say you want BIX
waitfor "Name? "         ; wait for BIX name prompt
transmit NAME            ; send your name
transmit "^M"            ; followed by a carriage return
waitfor "Password: "     ; wait for password prompt
transmit PASSWORD        ; send your password
transmit "^M"            ; followed by a carriage return
endproc
```

Life at 28.8

Testing performance of sophisticated communications software on fast computers requires fast modems. As luck would have it, Microcom sent two of its DeskPorte Fast 28.8-Kbps modems as I was putting this review together. With V.42bis data compression (up to fourfold under ideal circumstances for compression), these modems are supposed to handle throughput up to 115.2 Kbps.

If you've never worked with a truly high-speed modem before (and I don't mean a 9600-bps model), you're in for a shock the first time you dial into a system and get 80- or 90-Kbps throughput on a standard voice line. Not only is that much faster than most modems can handle, it's faster than many computers can handle. The serial port on a Mac is only set to do RS-232 asynchronous communications at up to 57.6 Kbps. A PC can handle 115.2 Kbps in theory, but most systems can't because of software overload. If you plan to do high-speed communications, you'll need one of the special communications boards like Hayes's ESP, or at least a serial port with a 16550 buffered UART to ease the load on the communications software.

If you're a Windows user, the problem is much more serious. Windows can't handle incoming serial streams at much over 9600 bps on most systems because of outdated 16450-type UARTs used to control the serial ports. With a newer 16550 UART you might get 19.2 Kbps, but nowhere near the speeds faster modems provide with V.42bis compression.

Microcom's solution is to put a parallel port on the modem and provide a driver that tricks your Windows communications software into thinking it's talking to a serial port. I installed the driver as COM3 on my notebook machine, and it worked exactly as advertised. Not only does the software run at full speed, but it frees up a serial port in case you're out of IRQs (interrupt request lines) on your Windows machine.

Many communications programs were written before anyone even conceived of a modem running at a DTE rate of 115.2 Kbps. Procomm Plus, for example, supports only standard Hayes connect messages. When the Microcom modem reported a 28.8-Kbps connection, Procomm didn't recognize it. I had to make that connection by dialing manually or through a script I wrote in Aspect.

As another example, the BBS software we use for distributing listings is an older version of Opus running on the Fossil serial driver. Fossil had no trouble handling the high data rates, but Opus was written to expect connect speeds of up to only 38.4 Kbps. When Fossil told Opus that it had connected at a serial rate of 115.2 Kbps, Opus got hopelessly confused and assumed a 300-bps connection. The data stream was fine, but Opus overestimated transfer times by many hours. As a consequence, I wasn't able to download files much bigger than a megabyte or two without exceeding my default time limit of 1000 minutes.

When V.34, the final V.Fast standard, is approved next spring or summer (or so people expect), don't think that you can simply buy a shiny new modem and connect it up. Your software may not understand the high-speed connect messages. You may have to replace your old nonbuffered serial ports with something better. Or perhaps you'll have to start over from scratch, as we'll have to do with our BBS. The 25-MHz 386 we normally use will barely keep up with that data rate; the serial ports certainly won't, and neither will the current software.

Should you buy a modem now? If you're equipping both ends of your data connection, there's no reason not to. All the modems available are based on the Rockwell chip set. Even though this set won't be compatible with the final standard, all the modems you can buy today are supposed to be able to talk to each other. Both Hayes and Microcom have committed to an upgrade program as well. For $39, Microcom will take back your DeskPorte and upgrade it to V.34, or send you the parts to do it yourself.

MAC

White Knight

White Knight from Freesoft is another package that started as shareware. Up through version 10, it was known as Red Ryder. Now in version 11, White Knight does just about everything you'd expect a world-class communications package to do. Mac software in general does a good job of adhering to Apple's Macintosh interface standards, and White Knight is no exception (see the screen).

I've used Red Ryder/White Knight for years on my old Macs (a 512K and an SE). In all this time, I can't remember ever opening the manual, and I'm sorry now that I didn't. Not only is the manual easy to understand, the foreword is downright fun to read. After reading that, I skipped over the user stuff and started reading through the scripting language specification. (In all this time, I've never found the need to work with White Knight scripts.)

White Knight's scripting language supports about 170 different functions. With them you can build scripts (or procedures) that add functions to the menu bar, for example, or that define macros triggered by on-screen buttons and icons. White Knight can also access external programs written as RCMDs (special plug-in code resources) that will do just about anything you like. One provided sample RCMD lets your procedures access MacInTalk (available separately from Apple) to give you spoken messages.

A White Knight script is a straight-line procedural program that starts at the top and executes to the end. The functions mostly mimic those available from the menus, but a few conditional statements let you compare strings and branch around in your program. Unexpected events are referred to as ALERTs, and White Knight can handle three of them at any time.

A typical procedure establishes a connection, sends some preliminary log-in strings to a host computer, sets ALERT conditions to handle an unexpected line drop, gathers up your mail, and then logs you off the host. Compared to some of the other scripting languages in this review, I found White Knight's procedures somewhat primitive but still functional.

MAC

MicroPhone Pro

Software Venture's MicroPhone Pro is available in both Macintosh and Windows versions. I looked at only the Mac version here. Like White Knight, MicroPhone Pro manages to be a full-featured communications package behind a user interface that conforms well to Apple's interface standard. I had no trouble learning all MicroPhone Pro's main features simply by examining the menus. I won't dwell on the user interface here because I'd be describing just about every Mac package you've ever seen.

MicroPhone supports fewer script commands than White Knight (only about 70), but it includes support for Apple Events and external programs (including MacInTalk support). Through Apple Events, you could have an Excel spreadsheet start up MicroPhone Pro, run a script to log into an on-line service, and grab current stock prices into Excel, for example.

MicroPhone Pro handles interrupt conditions through an elaborate WHEN statement. It doesn't set a resident condition handler like White Knight's ALERT, but rather suspends the script execution until the conditions match one of those specified in your WHEN statement. Possible conditions include specified incoming strings, some amount of wait time, a specified period of silence, a button press, or some expression coming true.

In theory, this should work just as well as the resident ALERT. In reality, I found it difficult to get some of my MicroPhone Pro scripts working the way I wanted, despite the excellent documentation. Developing scripts to access on-line services can be tricky, and I expect that getting MicroPhone Pro to handle unusual conditions will become easier as I spend more time with it.

COMMUNICATIONS SOFTWARE PERFORMANCE

Transfer rate between each software product and a BBS running on a 50-MHz 486 with a Microcom DeskPorte Fast modem, connected at 115.2 Kbps. The rate shown is the effective character rate in bits per second, allowing for Zmodem file transfer overhead, connect speed, and telecommunication software overhead. The uncompressed data rate is for a selection of text files. The compressed data rate is based on transferring files already compressed with PKZip. The faster transfer rates are the result of the modem's data compression and will vary according to the different programs' ability to handle fast data streams. Higher numbers indicate faster throughput. However, comparisons between platforms are meaningless because of hardware differences. (N/A = not applicable.)

PRODUCT	UNCOMPRESSED DATA	COMPRESSED DATA	UNCOMPRESSED (PARALLEL)	COMPRESSED (PARALLEL)
DOS software[1]				
Procomm Plus 2.01	59000	30000	N/A	N/A
Telix 3.21	64000	30000	N/A	N/A
Macintosh software[2]				
Microphone Pro 1.0	53000	29985	N/A	N/A
White Knight 11.14	57600	30520	N/A	N/A
Windows software[3]				
Procomm Plus 1.02 for Windows	18740	18300	48500	29750
Crosstalk for Windows 2.0	18900	18340	40900	32900
Unix software[4]				
Term 6.2	8800	5890	N/A	N/A

[1] Connection was made to a Microcom modem at 115.2-Kbps DTE speed; the modem-to-modem speed was 28.8 Kbps with MNP 10.

[2] Connection was made to a Microcom modem at 57.6-Kbps DTE speed; the modem-to-modem speed was 28.8 Kbps with MNP 10.

[3] Connection was made to a Microcom modem at 19.2-Kbps DTE speed; the modem-to-modem speed was 19.2 Kbps with MNP 10.

[4] Connection was made to an ATI V.32bis modem at 9600-bps DTE speed; the modem-to-modem speed was 9600 Kbps. File transfer protocol was Ymodem.

A sample CASL script from Crosstalk for Windows that logs onto MCI Mail.

```
label LOGIN
/* Try to log in to MCI Mail for 50 seconds. If not successful, then
hang up and exit. */
trys = 1
while online and trys < 5
  watch 10 seconds for
      quiet 2 seconds    : reply
      "name:"            : wait 5 ticks : reply UserID
      "password:"        : wait 5 ticks : reply Password
      "sorry, inc"       : wait 5 ticks : reply : bye : bye
      "COM"              : alarm 1 : message "MCI logon complete" : end
      "call Customer Service" : ALERT "Connection refused", OK : end
  endwatch
  trys = trys + 1
wend
```

Crosstalk for Windows

Crosstalk for Windows may not be the most popular Windows communications package, but the people who use it defend it passionately. During this review, it quickly became obvious why so many people (including a number here at BYTE) like it so much.

Crosstalk emulates most standard terminal types, handles a number of file transfer protocols (including a few that no other package handles), supports DDE functions, and allows connections through a network. The network support includes redirected BIOS access through INT 14, NASI (NetWare Asynchronous Services Interface), NCSI (Network Communications Services Interface), and the ACS (Asynchronous Communications Server) interface. The ability to access shared resources over a network is quickly becoming a required feature in most software packages. A few other Windows packages permit this, including the new version of Procomm Plus for Windows.

Configuring Crosstalk for a variety of communications sessions is simple because of the straightforward way DCA designed the setup interface. One menu choice brings up the settings dialog box, which has a number of subfunctions. Each of these is accessed through an icon button that—unlike most Windows icons—is clearly marked with text describing its function.

The toolbar (or Crosstalk's QuickBar) has a number of icons that are supposed to make using the package more convenient (see the screen). I found that few of them made any sense, and on a notebook display they were practically unreadable. If you like toolbars in other Windows programs, however, you may find them useful. I ended up turning them off and using the menus.

Besides strong network support, the other standout feature that makes Crosstalk worth consideration is its programming language, CASL (Crosstalk Application Scripting Language). CASL is an extension of the language used in earlier versions of Crosstalk. Programming in CASL is straightforward, and I found that programs generally work the way you expect them to. The sample CASL script listing is a routine for logging into a system. The CASL documentation is fat and daunting, but don't let that scare you.

Procomm Plus for Windows

Procomm Plus for Windows came onto the scene riding the coattails of its popular DOS cousin, Procomm Plus. The Windows version is more than a Windows interface glued onto the DOS program, however. Datastorm enhanced the Aspect programming language, for example, to support windows, bit-mapped graphics, and other Windows features. Procomm's Action Bar is one of the few comprehensible toolbars I've seen on a Windows package. It has only 10 icons, and about half of them actually make sense.

From the menus and dialog boxes (see the screen), you can manage your dialing lists, write and compile scripts, transfer files, and configure the program for any combination of modems and serial connections. I found both strong and weak points to the interface. The setup menu, for example, brings up a dialog box with a series of buttons. When you click on the Connection button, you can select from the predefined connections; double-click on it, and you can define new ones. While the double-click trick is convenient, it's not obvious; you must read the documentation. It would be nice if the selection menu also offered a New option.

If you often find yourself downloading GIF files, you may like Procomm's automatic GIF viewer. As soon as Procomm recognizes a GIF graphics file, it opens a window and displays the graphic as it downloads. Procomm also provides DDE server support. You can, for instance, have your spreadsheet open a communications session, dial an on-line service, grab warehouse inventory data, and return it to your spreadsheet.

If you ever find yourself reconfiguring your current package's Zmodem for different on-line services, you'll appreciate Procomm's ability to create new Zmodem options in the transfer menu with assigned names. For example, with some services you may want crash recovery; with others, you may not.

Term

Selecting the most popular communications product for Unix was tough. Unix enjoys a rich heritage of public domain software, so many application areas are fully addressed by software you can get for free. Communications is historically one of those areas. The most prevalent communications package in use on Unix systems is Kermit, available free from just about everywhere. In some cases, however, you may want technical support by phone, and that's where commercial products fit in. Century Software's Term is one of the few commercial products on the market.

Term is a standard communications package with terminal emulation, a selection of file transfer protocols, and a scripting language. When you establish a connection, you specify one of the devices provided on your system, typically one of the modems in your modem pool. I installed my copy of Term onto bytepb, our 486-based Unix System V release 3.2 system, which has two modems attached to it. The idea was to install the software there, and then telnet into bytepb and access Term to dial out to other systems.

Unfortunately, that didn't work. Term provides terminal emulation, but it also expects your terminal to support some emulation so that the program can control your screen. All the systems in BYTE's Unix Lab run graphics screens with X Window System, and Term doesn't support X. When I specified the terminal type as SCOANSI and ran from the system console, however, it ran fine. If you plan on using Term, check with the company to make sure the package will work in your environment.

Term's interface is perfectly usable, although it has an outdated feel to it (see the screen). Perhaps because of Term's stark character screens, it felt like I was running on an old LSI/11 from years ago. Still, configuring Term to access my test BBS went easily, and file transfers worked well. Term doesn't support Zmodem, and the BBS doesn't support Kermit, so I ended up using Ymodem for the file transfer tests.

Term's scripting language is powerful, with lots of functions, yet it still feels primitive compared to some of the other languages I used during this review. The programs end up resembling Aspect or CASL programs, only with shorter, more cryptic keywords.

Communications Solutions

I've used Procomm (the DOS version) on my DOS/Windows machines for several years now, and White Knight on my Mac ever since I bought it. Based on my evaluation experience, I might take a closer look at MicroPhone Pro. I didn't find Telix to be any better than Procomm—although it's just as good. If you are about to run out and buy a DOS communications package, download Telix first and try it.

Neither of the two Windows packages convinced me to stop running Procomm

New and Improved

Three of the packages reviewed here—MicroPhone Pro for the Mac, Procomm Plus for Windows, and Term—will be shipping in new versions by the time you read this. According to the vendors, here is what you can expect from the upgraded products:

According to Software Ventures, MicroPhone Pro 2.0 for the Mac adds support for simultaneous ongoing sessions, more terminal emulations, more and faster transfer protocols such as CompuServe B+, easier hardware configuration, keyboard mapping (handy for PowerBook users), and scriptable custom windows. For information junkies, Software Ventures has added a rich set of tools for navigating the Internet. The upgrade price is $59.95.

DataStorm has added fax support to Procomm Plus for Windows 2.0. You'll be able to load up to five Action Bars at the same time with the new version, and the Aspect language has been enhanced. Configuring your modem should be easier, with automatic detection of 500 different modems—Procomm will figure out which modem you have and configure itself automatically. Improvements to Procomm's host mode include fax capability that lets callers dial into your system to request faxes. Support for NASI/NCSI network connections is scheduled, and you'll be able to arrange your dialing directory into groups for easier access.

Century Software is updating the Unix version of Term to 6.3, adding in Zmodem, CompuServe B, and FTP file transfer protocols. The vendor will also add more terminal emulations and improve Term's capability for unattended automated file transfers. The upgrade price for current Term users will be $189, directly from Century Software.

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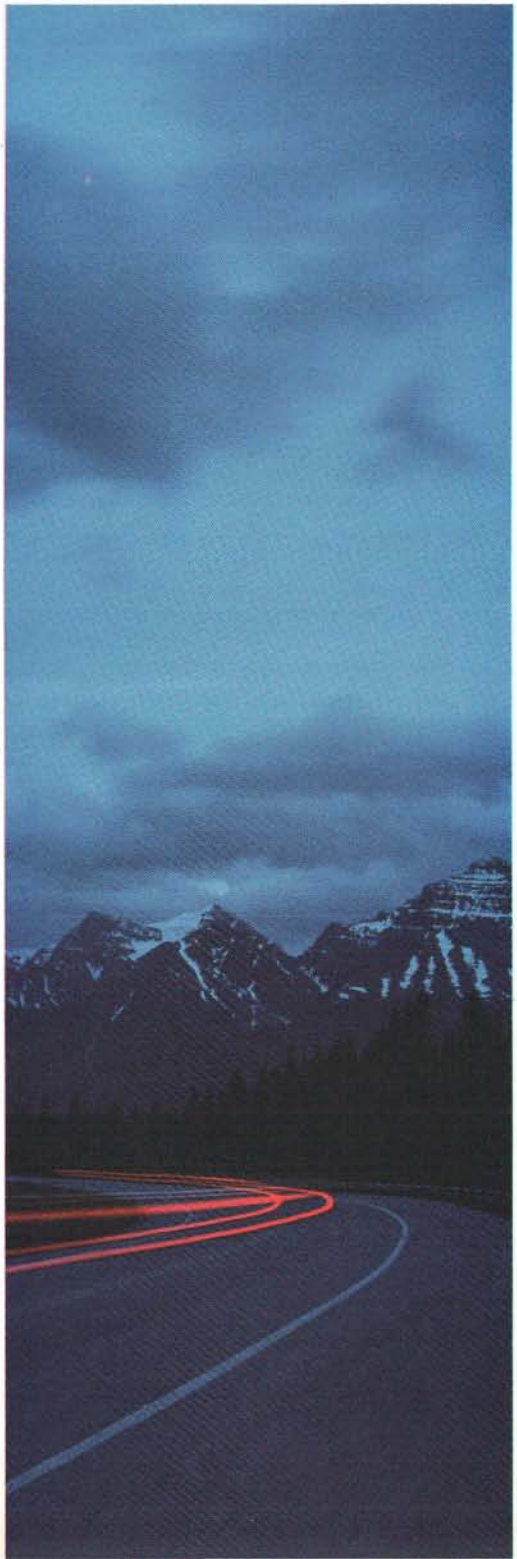

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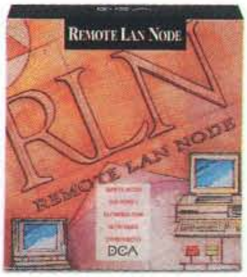

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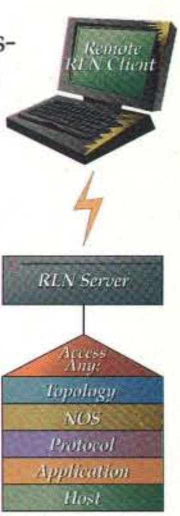

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yes
It runs with NetWare

DCA

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in a DOS window. Under Windows, the DOS version of Procomm manages better throughput at 2400 bps than the Windows communications programs, runs in the background, and has a simpler interface. When I need to transfer files faster than 2400 bps (that is, if our town, Peterborough, ever gets a faster Tymnet node), I'll have to choose between running the DOS Procomm package alone, without the speed restrictions of Windows, or clogging up my hard drive with a slower, fatter Windows package to get background communications. Perhaps by the time I need a faster Windows package, something better will have come along.

About the Products

Crosstalk
for Windows 2.0 ....$179
Digital Communications
Associates, Inc.
1000 Alderman Dr.
Alpharetta, GA 30202
(800) 348-3221
(404) 442-4095
fax: (404) 442-4366
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MicroPhone Pro 1.0.....$295
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Berkeley, CA 94705
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Procomm Plus 2.01 .....$129
Procomm Plus
for Windows 1.02.........$179
Datastorm Technologies, Inc.
3212 Lemone Blvd.
P.O. Box 1471
Columbia, MO 65205
(314) 443-3282
fax: (314) 875-0595
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Telix 3.21 ....$39 (shareware)
deltaComm Development, Inc.
P.O. Box 1185
Cary, NC 27512
(800) 859-8000
(919) 460-4556
fax: (919) 460-4531
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Term 6.2 ....$495
for Interactive Unix single-user
version (tested)
Century Software
5284 South 320 West,
Suite C134
Salt Lake City, UT 84107
(800) 877-3088
(801) 268-3088
fax: (801) 268-2772
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White Knight
Telecommunications
Software 11.14.............$139
The Freesoft Co.
105 McKinley Rd.
Beaver Falls, PA 15010
(412) 846-2700
fax: (412) 847-4436
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Besides working with Term on the Unix system, I installed the DOS version. It may take you some time to get used to the interface, but the wide support of Term on Unix, VMS, DOS, Windows, Macintosh, and BTOS systems may make it the perfect solution for your environment.

You shouldn't overlook the cheap and free options, either. Kermit is available for just about every computer made. There are also a number of interesting DOS solutions besides Telix, and Macintosh communications enthusiasts are just as likely to suggest ZTerm as any commercial solution. Explore your local BBSes and online services first. But if shareware isn't what you want, one of these commercial packages could be just what you're looking for. ■

Howard Eglowstein is a testing editor for the BYTE Lab. He can be reached on the Internet or BIX at heglowstein@bix.com.

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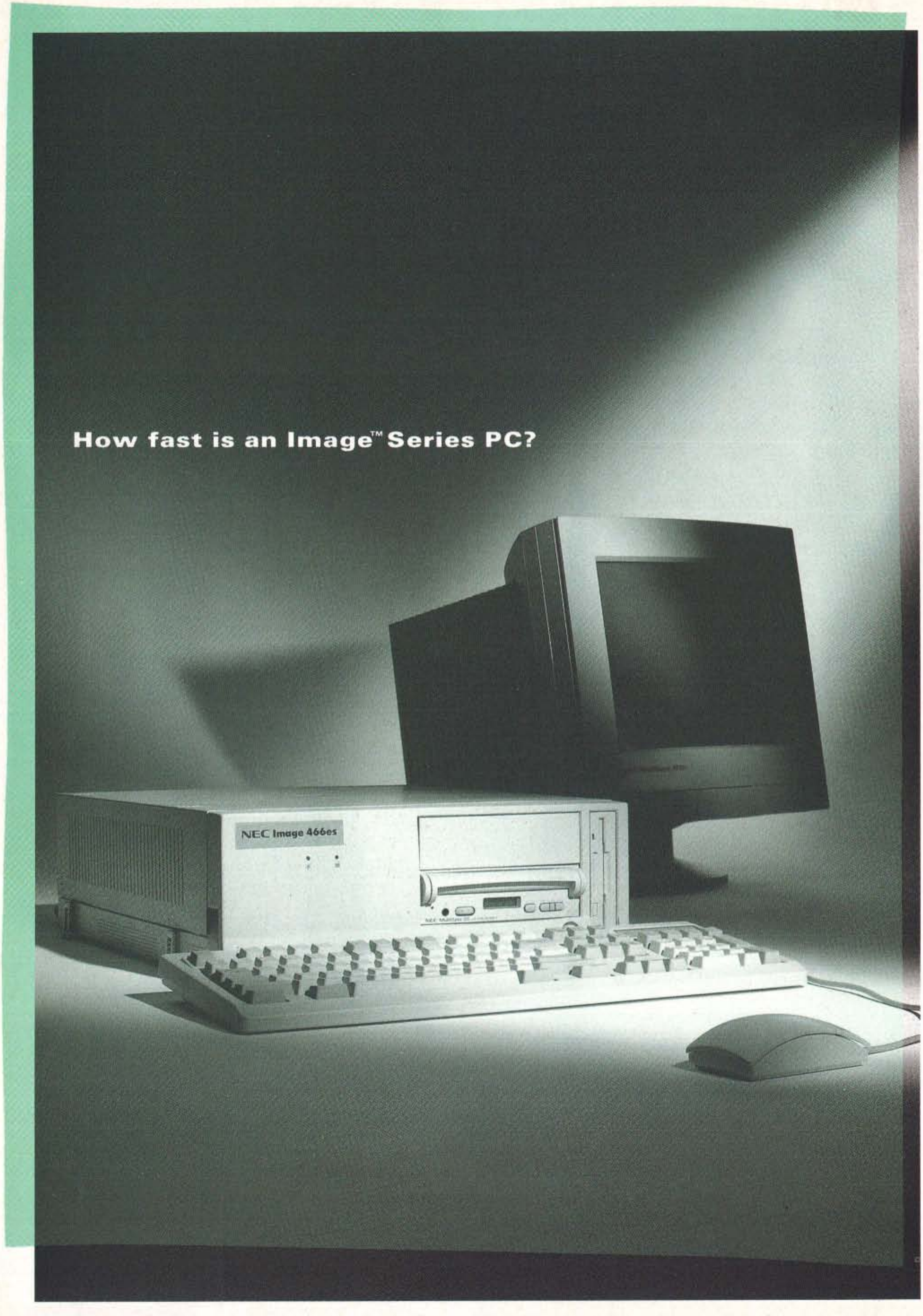
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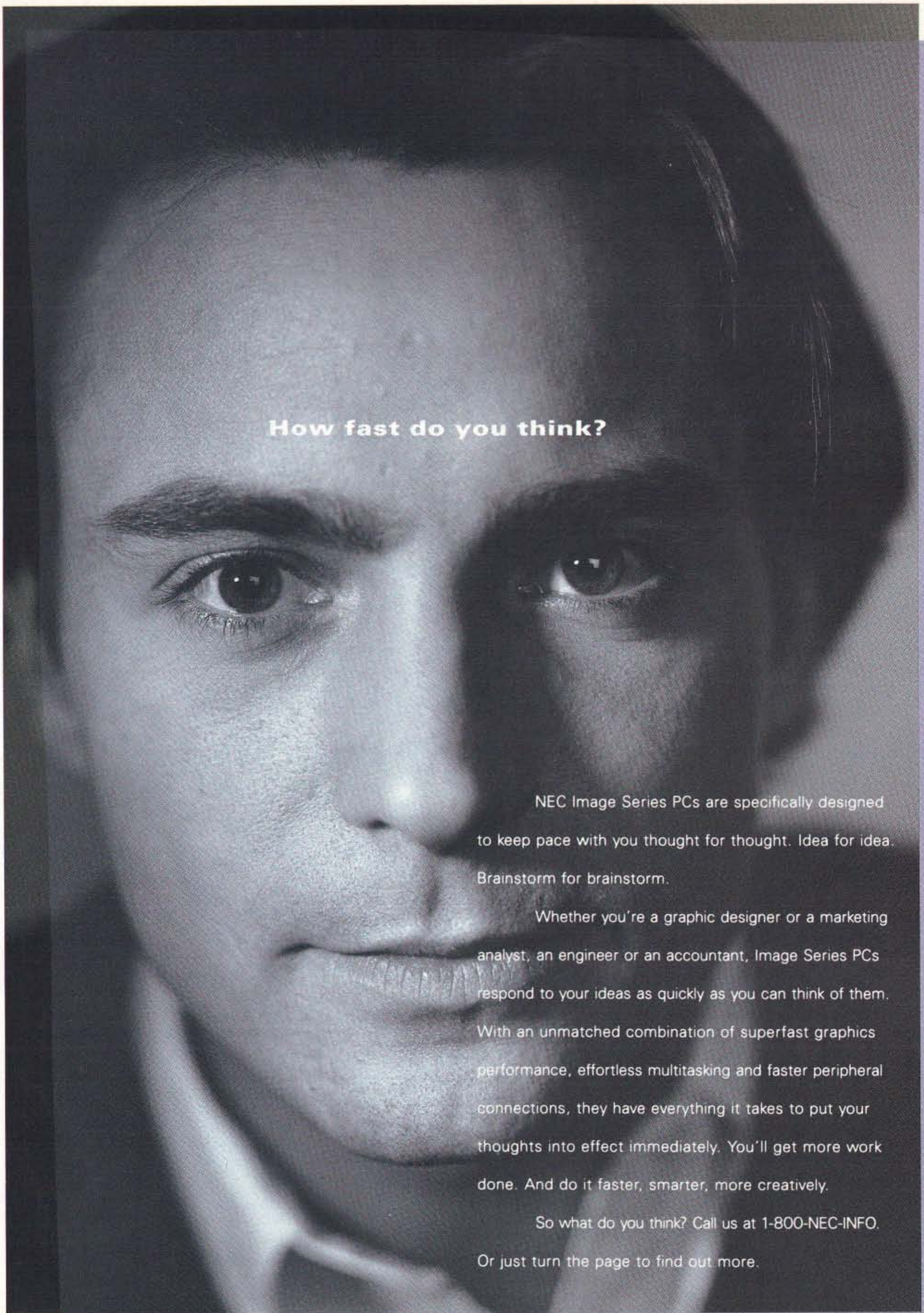
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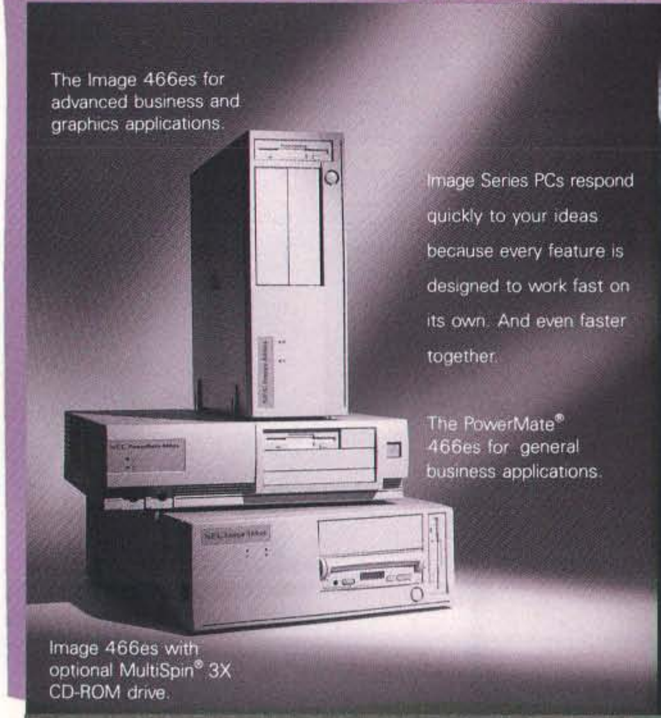
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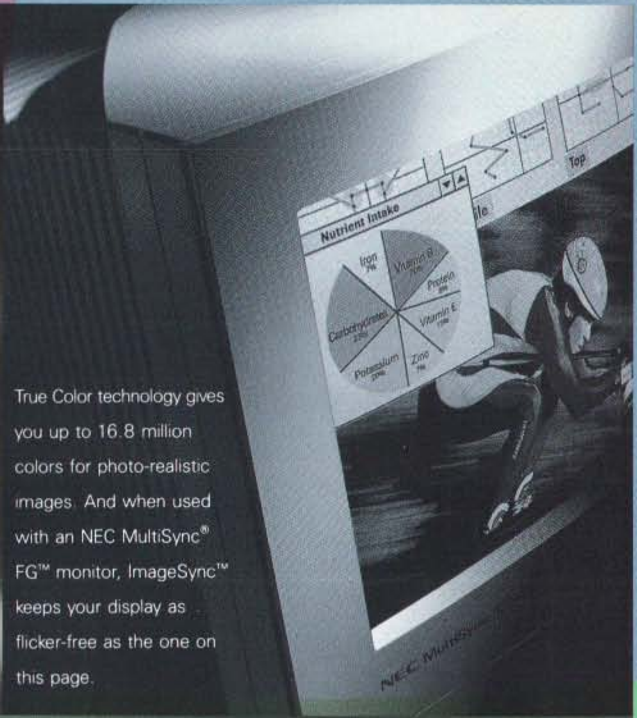

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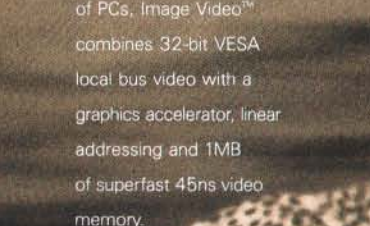

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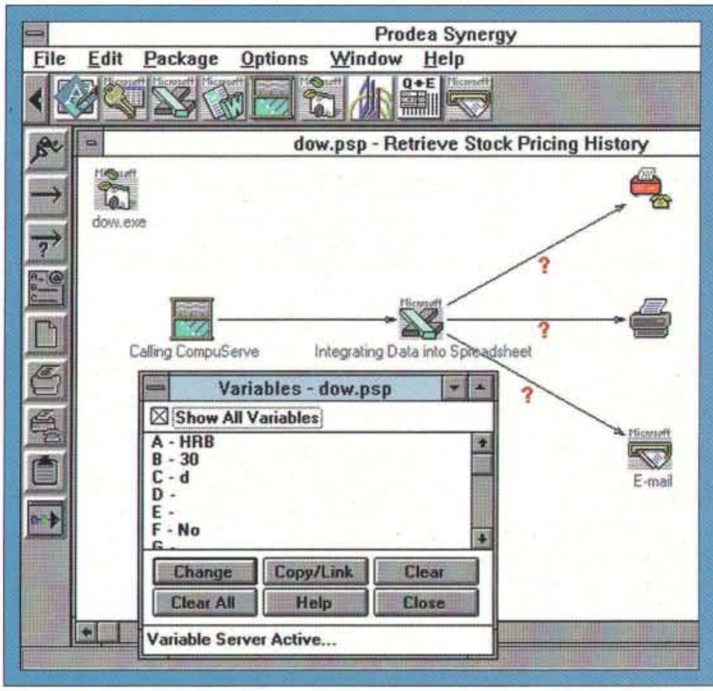
A New Synergy for Windows

ProdeaSynergy's graphical tools let you create complex scripts for automating Windows tasks across many different applications

STEVE GILLMOR

Sometimes in sports or the arts, a performer arrives with a talent so great that he or she makes the most difficult feats seem easy. Such is the case with ProdeaSynergy, a new application-integration software package that at first glance does not appear to have all that much to it. It's only when you try to accomplish what it can do in some other way that you begin to appreciate what is going on behind the scenes.

In simplest terms, ProdeaSynergy is a Grand Central Station that serves as the hub connecting software like databases, spreadsheets, and communications programs, both on individual machines and across a network. The visually oriented Windows development environment lets you derive data from any source, massage and format it, and then send it on via conditional choice of E-mail, fax, paper, or disk. You can do all this without needing to know the intricate details of proprietary messaging techniques, programming tools, or file-format compatibility.



A - HRB
B - 30
C - d
D -
E -
F - No

Variable Server Active...

Icons in the ProdeaSynergy Workspace represent application and system objects that retrieve, process, or store information. You then represent the movement of data between these objects by placing arrows from source to destination icons. Arrows with question marks show conditional processes. The Variable Server dialog box lets you monitor the changing values of variables during execution and debugging of your package. Variables can represent values within an application, with conditional arrows, and within most fields of ProdeaSynergy dialog boxes.

The Elements of Synergy

The power of Prodea's automated scripts depends on the software applications and desktop tools available to you locally or over a network. ProdeaSynergy can mediate between packages, selecting the best common format and the optimum interchange method, but it is not a programming language; it can't provide applications with any missing functionality. It also can't assume control from within an application. If you want to automate a procedure from within Excel, for instance, you'll need to develop an Excel macro to do the processing. You then use ProdeaSynergy to pass the output of the macro to other applications.

In the final analysis, a process automated by Prodea's software will work only as well as the mechanisms used to drive it. ProdeaSynergy is not a replacement for cross-application automation tools like Visual Basic for Applications or OLE 2 Automation. In fact, as VBA and OLE 2 Automation become more widespread, Prodea will be able to leverage these tools to link applications together in a visual way and facilitate development across several applications.

ProdeaSynergy has three major elements: the ProdeaSynergy Package, the ProdeaSynergy Library, and the Variable Server. You create packages by placing icons in the ProdeaSynergy Workspace that represent application and system objects that retrieve, process, or store information. You then represent the movement of data between these objects by placing arrows from source to destination icons. After defining object and arrow properties, you choose the Runner icon to execute the package.

The ProdeaSynergy Library provides a simple GUI where you can organize and launch various packages. Once created, a package can be published in a designated library, which can then be saved, copied, or E-mailed to another machine. A separate executable file that you can launch from the Workspace, the ProdeaSynergy Library supports password-protection security features; a subdirectory tree structure to group packages by related topics; and appearance options to modify the color scheme, the size and type of buttons, and icons that represent topics and packages.

The Variable Server leverages ProdeaSynergy's ability to resolve relationships and communications at run time rather than at build time. The Variable Server provides 260 predefined global variables that can be set and referenced by each of the programs you are running in a package. These variables can be manipulated via DDE, OLE, and application menu add-ins that ProdeaSynergy often installs in a process dubbed *synergizing*. You can use variables with conditional arrows to control where the data flows based on changes at run time.

Application Support

When you install ProdeaSynergy, it prompts you to select and define the applications you have on your system. The program accesses the Application Services Database, a predefined list of DOS and Windows applications that contains basic information such as program name and location, type or class of application, messaging protocols supported, and file formats supported. The Database also contains the key set of application functions and commands that ProdeaSynergy needs

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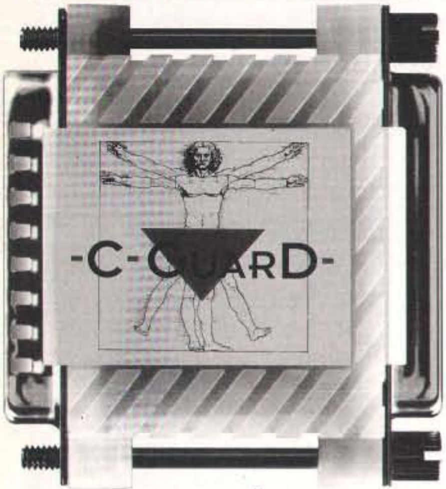

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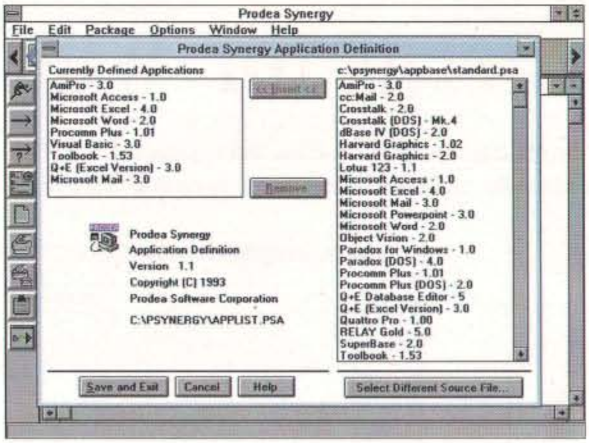

Currently Defined Applications

AmiPro - 3.0
Microsoft Access - 1.0
Microsoft Excel - 4.0
Microsoft Word - 2.0
Procomm Plus - 1.01
Visual Basic - 3.0
Toolbook - 1.53
Q+E (Excel Version) - 3.0
Microsoft Mail - 3.0

Prodea Synergy
Application Definition
Version 1.1
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Prodea Software Corporation
C:\PSYNERGY\APPLIST.PSA

c:\psynergy\appbase\standard.psa

AmiPro - 3.0
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Microsoft Access - 1.0
Microsoft Excel - 4.0
Microsoft Mail - 3.0
Microsoft Powerpoint - 3.0
Microsoft Word - 2.0
Object Vision - 2.0
Paradox for Windows - 1.0
Paradox (DOS) - 4.0
Procomm Plus - 1.01
Procomm Plus (DOS) - 2.0
Q+E Database Editor - 5
Q+E (Excel Version) - 3.0
Quattro Pro - 1.00
RELAY Gold - 5.0
SuperBase - 2.0
Toolbook - 1.53

The Application Definition dialog box is available during installation or any time you want to update or add new applications. You can define applications that reside on both local and network drives.

to instruct each application to perform its tasks within the package.

You highlight each new application name in the list on the right side of the Application Definition dialog box and then click the Insert button to add the name to the Defined list on the left. ProdeaSynergy verifies the presence of the application on your system before inserting the name. If it doesn't find the application, the program gives you the opportunity to enter the appropriate path or choose the Browse button if you need help.

You can also use one of several "Any" applications to define your own applications within a class (e.g., word processor, spreadsheet, or database), to provide support for tools that are not currently predefined in the database. Prodea is constantly updating this data, which resides in files separate from the ProdeaSynergy main executables. Thus, you can get support for new programs and upgraded versions of existing products by downloading from the Prodea BBS or by mail, without needing to upgrade ProdeaSynergy itself or alter your existing packages and libraries.

The Workspace has five major elements: the Application Toolbar, the System Toolbar, the Menu Bar, the Status Bar, and the Package Window. Defined applications are represented by their program icons in the Application Toolbar, which runs across the top of the screen. You can double-click on an icon to run the associated application from within ProdeaSynergy.

Putting ProdeaSynergy to Work

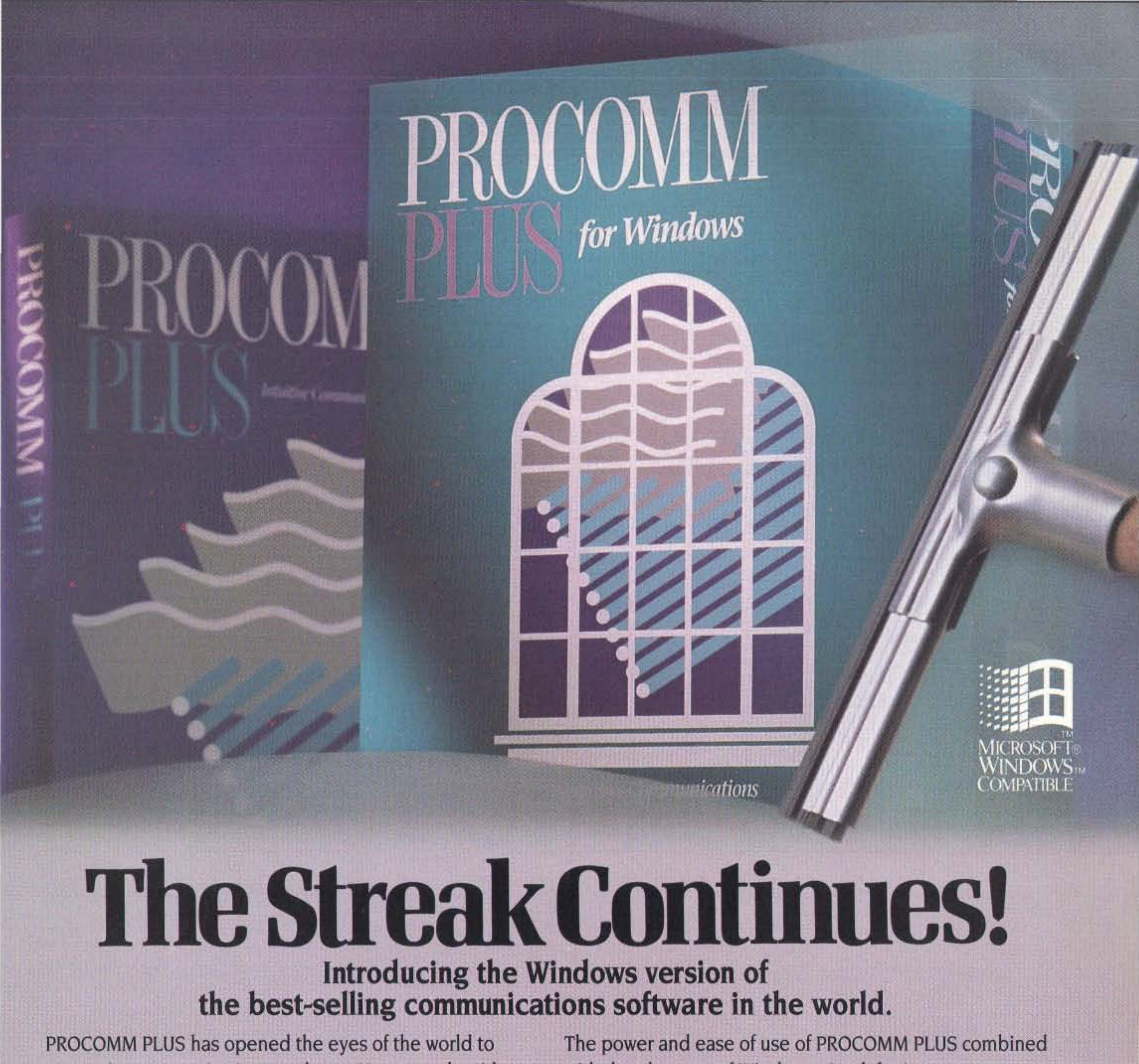
Creating a package couldn't be easier—you just click and drag an icon into the Package Window. Start with a simple example. Suppose you need to generate a monthly report with data you regularly enter into a spreadsheet. Each month, you need to move a range of cells from the spreadsheet, place the data in a word processing document, and then print the document. After creating a new ProdeaSynergy Package, you would drag the appropriate spreadsheet icon to the upper left corner of the Package Window. Don't worry if you have Excel and you are creating a package to run on a machine that has only Lotus 1-2-3; ProdeaSynergy can automatically substitute one spreadsheet application for another at run time.

Next, you select a word processor icon, drag it just to the right of the spreadsheet icon, and connect the two icons with an arrow showing the direction of the data flow. Finally, you select the Printer icon from the System Toolbar, drag it to the right of the word processor icon, and connect the two icons with an arrow. You can also add conditional arrows if you have more than one possible outcome.

Before continuing with the package design, you need to access a spreadsheet that contains the range to be moved. You can access the spreadsheet from within ProdeaSynergy by right-clicking on the spreadsheet icon and entering the worksheet filename in the appropriate field of the Application Object Properties dialog box. If you've defined a range, you need to right-click on the arrow between the spreadsheet and the word processor and enter the name of the range in the Range Definition From: field. Otherwise, all the data within the worksheet will be moved with no further work on your part. Click on the Runner icon, and your package will execute.

Intelligent Choices

ProdeaSynergy manages and mediates between the applications, data files, and output devices you selected in creating the package. Moving your completed package to another machine reveals much more about ProdeaSynergy's underlying power. Perhaps the spreadsheet you employed on the original system is not available on another desktop. When you run the package on the new machine, ProdeaSynergy searches the Application Services Database for Excel and, not finding it, suggests Lotus 1-2-3 as a suitable replacement. The



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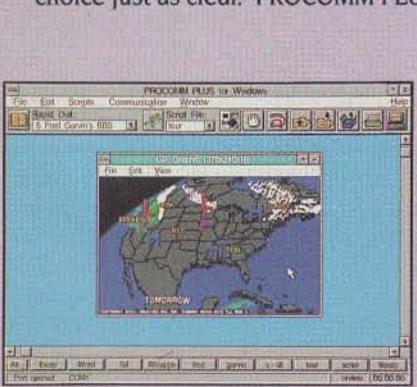

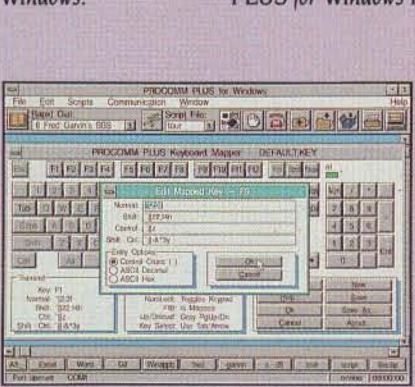

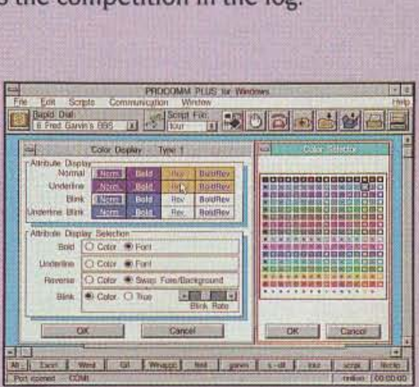

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"FirstClass Outperforms Competitors Easily" BYTE Magazine 09 /93

More than just a leading multi-platform ***e-mail*** system, FirstClass features ***electronic conferencing*** and ***remote access***—all in the same package.

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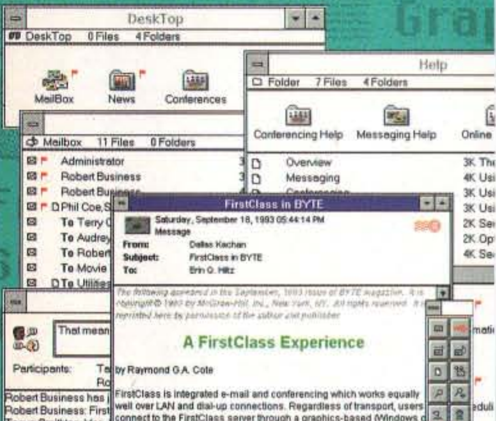
BYTE magazine says "FirstClass blends conferencing and mail together under a remarkably clean interface that goes far beyond the capabilities of most mail systems ... ***a regrettably rare example of useful software.***"



Saturday, September 18, 1993 05:44:14 PM
Message
From: Dallas Kachan
Subject: FirstClass in BYTE
To: Erin G. Hiltz

A FirstClass Experience

by Raymond G.A. Cote

FirstClass is integrated e-mail and conferencing which works equally well over LAN and dial-up connections. Regardless of transport, users connect to the FirstClass server through a graphics-based (Windows

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Excel macros. *To replace a range of data with new data and then redefine the range, you'd have to write an Excel macro. ProdeaSynergy handles the chore seamlessly.*

```
GET.DOCUMENT(1)
IF(NOT(ISBLANK(argRange)))
  SELECT(GET.FORMULA(argRange))
END.IF()
IF(argFormat>0,EDIT.DELETE
     (argFormat),CLEAR(3))
END.IF()
OPEN(argFile,0)
GET.DOCUMENT(1)
SELECT.LAST.CELL()
SELECT(!A1:ACTIVE.CELL())
COLUMN.WIDTH(,,,3)
COPY()
ACTIVATE(C6)
PASTE.SPECIAL(2,1,FALSE,FALSE)
DEFINE.NAME(GET.FORMULA(argRange))
ACTIVATE(C13)
CANCEL.COPY()
ERROR(FALSE)
CLOSE()
ERROR(TRUE)
RETURN()
```

program uses built-in search heuristics to find files used in a package if they have been moved or, as is often the case, are stored in different locations on other machines.

Similarly, you may have defined Microsoft Mail as your package's Windows E-mail application, while another system uses Lotus cc:Mail. ProdeaSynergy automatically makes the appropriate adjustments, transparently switching messaging protocols from MAPI to VIM. Depending on the protocols supported by applications and registered in the current Application Services Database, ProdeaSynergy might use DDE to communicate with Quattro Pro for Windows, a combination of DDE and OLE with most word processors, and, if necessary (as in the case of Harvard Graphics), keystrokes.

ProdeaSynergy identifies and exploits the "richest" data/file format shared by source and destination applications. When you select two objects that don't have a compatible transfer file format, the Windows Clipboard can sometimes be used as an interface to automatically reformat source data and pass it on. For example, a graph created in Excel can be converted via the Clipboard icon to be read into a Word for Windows document, while the cell data is moved via DDE and a temporary file that ProdeaSynergy creates at run time.

Taken together, these automated services shield the user from much of the complexity in creating enterprise-wide integrated tools. Yet ProdeaSynergy goes beyond ease of use in some instances to perform feats that are difficult to accomplish with other methods.

Taking Stock

Take the example of a package designed to perform stock pricing analysis by downloading data from CompuServe, integrating it into a spreadsheet report, and then E-mailing, faxing, or printing the results based on user-defined instructions. First I'll describe how ProdeaSynergy constructs the package and then how, or if, it can be done another way.

You begin by using Visual Basic, Toolbook, or another authoring program to create a front-end user interface for entering user ID, password, stock symbol, period, and output choices. These values are sent via DDE commands to the Variable Server and are subsequently available to other applications running within the package.

Next you use Procomm Plus for DOS to record a script that logs onto CompuServe and downloads historical stock price data. You then press the Control key while double-clicking on the Procomm icon to open the script file and replace specific user information with variable references. ProdeaSynergy automatically substitutes these values in the script file before launching the communications program and then waits for its completion.

To import new pricing information, you create a spreadsheet in Excel and define a range to receive data. Next, draw an arrow from Procomm Plus to Excel and specify the input range in Excel in the Arrow Properties dialog box. ProdeaSynergy automatically replaces the specified range in Excel with the new information each time the package is run, resizing the range to fit as well.

If the stock price is up, the package should create a short note with the current price and send it with the attached spreadsheet to management via Microsoft Mail. You do this by drawing a conditional arrow from Excel to Microsoft Mail, which automatically brings the spreadsheet in. Use Notepad to create the note, adding a variable from the Variable Server to represent the current price. Enter the resulting filename in the Message Text field of the Application Object Properties dialog box. Also enter the variable containing the manager's name in the To: field. ProdeaSynergy automatically performs a comparison at run time; if the price is up, it substitutes the price in the note and E-mails the results with the spreadsheet.

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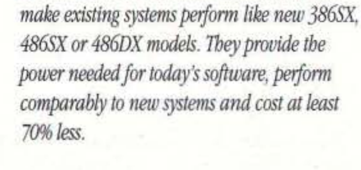

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Landmark Speed 2.0:	39 MHz	84 MHz	84 MHz	IBM PS/2 Models 70 and 80, Compaq Deskpro Models 386/16, 386/20, 386/20e, 386/25, 386/25e, 386/33
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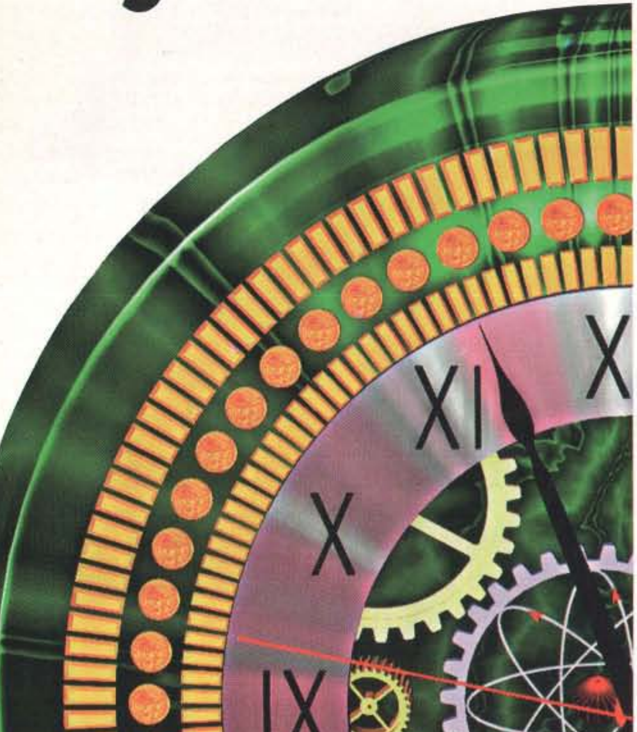

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arrows are configured in a similar fashion, with the complete package then published to a library. The great majority of development time here is spent in creating the user interface, recording the Procomm Plus macro script, and creating the Excel spreadsheet.

The Hard Way

To duplicate this project with Visual Basic or a similar authoring program, you would begin by designing the same user interface that served as a front end to the ProdeaSynergy package. Recording the Procomm script would also be the same. But then the two paths quickly begin to diverge.

To emulate ProdeaSynergy's run-time script-variable substitution, you need to write a Visual Basic routine that reads through the entire script and replaces prompted fields, or one that generates the Procomm Plus script on the fly, filling in the necessary information.

Now you hit a major roadblock: Visual Basic needs to launch Procomm Plus for DOS and wait for it to complete execution of the script. Unfortunately, however, Visual Basic's Shell function runs other programs asynchronously. You can't be sure Procomm Plus has finished executing before your Visual Basic code continues on, and the workarounds are kludgey.

So, instead, you might use Procomm Plus for Windows and add commands to the recorded script to send DDE messages to Visual Basic when the script has completed. You also need to create Basic DDE server routines that wait in a procedural loop. You're leveraging two different programming tools here, with limited documentation another factor to consider.

If you test the application at this point, you'll notice that Procomm Plus for Windows won't overwrite an existing data file using CIS-B+ protocol, so what works the first time will not work the next. You need to add some Visual Basic code to handle this, while ProdeaSynergy's Application Services Database is aware of this anomaly and automatically deletes the file before running the package.

Using DDE to interface with Excel is easier than with some other products, but you'll probably have to use a combination of DDE commands and Excel's macro facility to emulate the ProdeaSynergy package. Excel does not have a built-in mechanism to replace an existing range with new data and then redefine the range to include only this new data. The "Excel macros" listing shows some sample commands that would perform that task.

Since it's not possible to pass arguments to Excel macros via DDE, Visual Basic would need to POKE the values into the macro sheet or find some other way to duplicate ProdeaSynergy's run-time variable substitution.

As noted earlier, ProdeaSynergy can automatically switch messaging protocols, but in Visual Basic, you'd have to build both MAPI and VIM functionality into the application. You'd need to code all conditional logic and variable substitution, and to prepare modified versions for each target machine around the network. What would take an hour or two with ProdeaSynergy might take a day or two at best, if the project was ever undertaken at all.

You can see some of what ProdeaSynergy does under the hood by using the Watch feature, which posts much of the messaging data as the program steps through a package. You can toggle the Variable Server window so that it stays on top of your screens and use the Step function to debug your work.

Wish List

Looking to the future, it would be nice if you could define new applications in a more robust fashion than is currently possible. The Any application interfaces are limited in their configurability, and the fax functionality does not allow complete hands-off automation of programs like WinFax Pro. Some integration with a robust macro recorder would also be desirable; the Windows Recorder is not directly supported in the Application Services Database. ProdeaSynergy is a DDE-aware application, so you can integrate it with your existing development environment.

With the imminent arrival of OLE 2 Automation, ProdeaSynergy is ideally positioned to leverage the interapplication power now available with off-the-shelf software. The program delivers a unique combination of embedded intelligence and ease of use. ■

About the Product

ProdeaSynergy............$495
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HOOPS 4.0: Beyond 3-D

The common API to most 2-D and 3-D libraries and hardware now offers a real-time mode and a powerful font engine

JOEL ORR

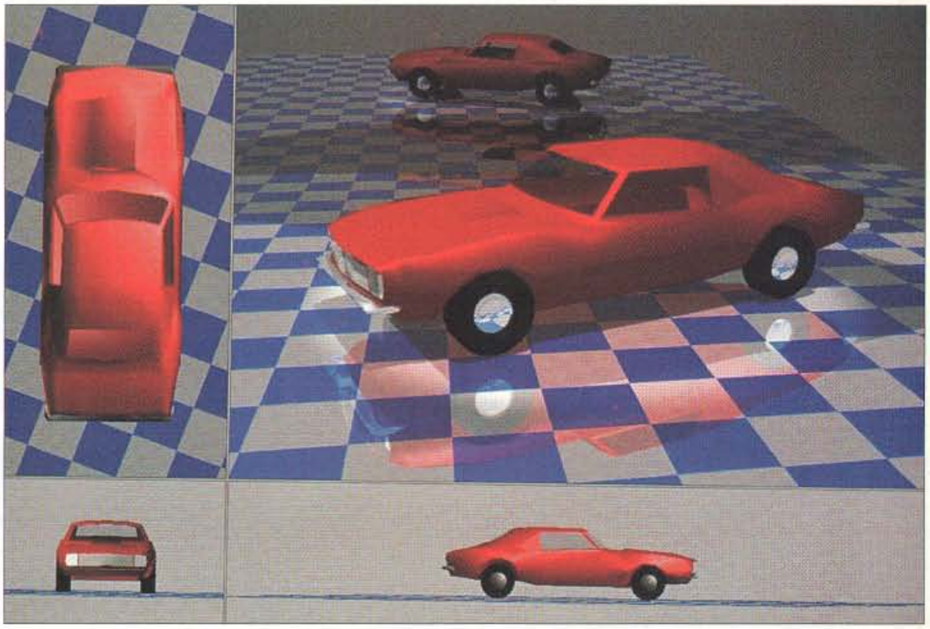
The latest release of HOOPS, Ithaca Software's Hierarchical Object-Oriented Programming System, firmly establishes it as far and away the best tool for almost any kind of graphics programming—2-D and 3-D CADD, raster data processing, data representation graphics, and more. HOOPS supports graphical formats ranging from 2-D wireframe rendering through interactive photorealism, as well as interactive display and hard copy, on platforms that range from Macs and 386-based PCs through high-end workstations. It has been selected for commercial use by some of the leading makers of CAD/CAM, mapping, scientific visualization, and multimedia software, including Autodesk and Computervision.

Like PostScript, HOOPS is truly platform independent. Graphics produced with HOOPS are 100 percent source code compatible across every major PC and workstation platform. Because of the product's scalable graphics pipeline, HOOPS programs run unaltered on all the platforms, taking advantage of special-purpose graphics hardware when it is present and substituting software for it when it is not.

What Is HOOPS?

HOOPS is a subroutine library, a programming framework, or an API, depending on how you look at it. It is a declarative language: When you program in HOOPS, you view the universe that you affect as being in a particular default state; to change anything, you declare it to have a new value. Thus, you declare the existence of graphical entities, their locations, their attributes, and so on, and HOOPS acts on your declarations. To see your geometry, you insert cameras.

HOOPS's hierarchical nature is similar to that of PHIGS, a standard implemented by several companies. (HOOPS has defeated PHIGS's bid to be the standard in commercial applications.) All HOOPS programs consist of segment trees, which resemble a Unix file structure—in fact, HOOPS uses the same segment-naming conventions. A segment contains a list of geometry, a list of attributes, and a list of subsegments. The tree has a "root" segment and subsegments. Subsegments—"leaves" of the tree—inherit the parent segments' attributes unless they contain declarations that change them. If they do, their subsegments inherit those changes.



The latest release of HOOPS *from Ithaca Software delivers a rich library of graphics routines to a remarkable number of platforms. This screen was generated by the code in the listing "Sample HOOPS program."*

In Name Only

Object-oriented is not an accurate description of HOOPS; the phrase was incorporated into the product name before the Smalltalk meaning was well established. In that HOOPS is declarative and nonprocedural and supports hierarchy, it is reminiscent of an object-oriented system. But it does not have separate classes and methods, nor does it support true instantiation or polymorphism.

In the world of graphics programming, two approaches are common: retained (or display-list) graphics and immediate-mode graphics. In retained graphics, the graphical database is used to construct an intermediate RAM-based file that is optimized for fast drawing. In immediate-mode graphics, the graphical database is used to redraw the screen after each change.

Each approach has its strengths and weaknesses. Display lists allow faster and smoother redraws, but they challenge the programmer to maintain parity between the two representations of the data. Immediate-mode graphics always accurately reflect the integrity of the graphical database, but they need much more hardware horsepower to produce a level of performance similar to that of retained graphics. With retained-graphics systems like HOOPS, the programmer can work in higher-level constructs than with immediate-mode systems, so there is less programming drudgery.

Display lists are the approach of choice when the graphics do not change frequently, as in CADD. Immediate-mode graphics work better when the entire image changes often, as in some kinds of scientific visualization.

Tom Gross of Computervision describes the operation of HOOPS succinctly: "There are essentially four levels of data processing inside HOOPS: A *tree-walker* traverses the HOOPS display list and outputs data structures to the *segment renderer*, which converts them to 3-D floating-point graphics primitives. [These primitives] are then

Drawing a line.

```
static float points [ ] = (0.2, 0.2, 0.0,
0.4, 0.7, 0.0, 0.6, 0.3, 0.0, 0.8, 0.8, 0.0);
main ( ) {
  HC_Open_Segment ("?picture");
    HC_Insert_Polyline (4, points);
    HC_Set_Line_Pattern ("-.-.");
    HC_Set_Color ("lines = red");
    HC_Set_Line_Weight (2.0);
  HC_Close_Segment ( );
  HC_Pause ( );
}
```

converted by the *3-D renderer* into 2-D integer graphics primitives and rendered by the *2-D renderer*. Depending on the current hardware platform, all or only some of this internal HOOPS processing might be performed by Ithaca's code." HOOPS understands the platform well enough to take advantage of its local graphics power.

New Features

One of the new features of HOOPS 4.0 is HOOPS I.M. (for *immediate mode*). You can now intersperse immediate-mode commands in HOOPS programs while retaining the platform independence for which the product is famous.

HOOPS I.M. lets programmers embed user-defined graphics primitives and rendering techniques within the HOOPS segment tree. When these references are encountered during traversal, I.M. provides more direct control over how retained data is rendered, or it renders the application's own data directly. This mixed-mode system lets the programmer combine the best of both architectures in a unified manner.

In recognition of the de facto merger of computer typography into general graphics, HOOPS now sports a powerful font engine. TrueType and Adobe Type 1 fonts are supported.

Ithaca Software also offers a rendering system that integrates with the HOOPS framework: HOOPS A.I.R., based on technology licensed from Hewlett-Packard. World-class ray-tracing and radiosity computations are as accessible as all the other HOOPS capabilities and are just as platform independent; scan-line and z-buffer rendering is also supported. You can have constant, Gouraud, or Phong shading; contour, texture, bump, and environment data mapping; transparency; translucency; and reflectivity. With A.I.R., you can create interactive walkthroughs of radiosity-illuminated photo-realistic scenes. (For more information on radiosity, see "Radiosity," May 1992 BYTE.)

One problem with graphics APIs has been their specificity. Some are designed for 2-D page description (PostScript); others deal with 2-D graphics and text but not 3-D (GDI, QuickDraw); some are specialized for 3-D (OpenGL, PEXlib); and others deal exclusively with image data (XIE). Unfortunately, few can combine all of these—and none can do so in a portable way.

Portability

Portability is the major strength of this programming environment. HOOPS supports Apple System 7; DEC VMS, Ultrix, and OSF/1; HP UX; IBM AIX and OS/2; Microsoft DOS and Windows NT; Silicon Graphics Irix; Sony News; and Sun Solaris. HOOPS supports common graphical data formats: EPS, CGM, DXF, HMF, IGES, and PICT. It also supports FORTRAN, C, and C++ bindings, along with optimized interfaces to GDI (for Windows), GPI, GL (Silicon Graphics), HPGL, PEXlib, PostScript, QuickDraw (Macintosh), Starbase (HP), XGL (Sun), and Xlib.

All the users I spoke with emphasized HOOPS's ease of learning and ease of use. HOOPS code is readable and concise. The source code in the listing "Drawing a line" shows what it takes to do just that. The "Sample HOOPS program" listing creates and displays four distinct views of an archived object. `Read_Metafile` causes the data from the HOOPS metafile `car` to be read from disk and placed in the segment named `?include library/car`. The `Include_Segment` places a reference to the car data into each of the four child segments.

In the segment `front end`, no camera setting is made, so the segment inherits the default camera settings. In the other `*view` segments, the `Orbit_Camera` utility is used to modify the camera in the scene. The `Set_Window` commands subdivide the higher-level window into four quadrants. The projections created by

Sample HOOPS program.

```
float target[ ] = (0.0, 0.0, 0.0)
float position[ ] = (1.0. 7.0, 2.0)

main ( ) {
  HC_Define_Alias ("?car","?include library/car");
  HC_Read_Metafile ("car.hmf","?car","");
  HC_Define_Alias ("?mirror wall","?include library/mirror wall");
  HC_Read_Metafile ("mirror wall.hmf","?mirror wall","");

  HC_Open_Segment ("?picture");
    HC_Set_Color ("windows=gray")

  HC_Open_Segment ("front view");
    HC_Set_Window (-1.0, -0.5, -1.0, -0.5);
    HC_Include_Segment ("?car");
    HC_Orbit_Camera (0.0, 0.0)
  HC_Close_Segment( );

  HC_Open_Segment ("side view");
    HC_Set_Window (-0.5, 1.0, -1.0, -0.5);
    HC_Include_Segment ("?car");
    HC_Orbit_Camera (90.0, 0.0)
  HC_Close_Segment( );

  HC_Open_Segment ("top view");
    HC_Set_Window (-1.0, -0.5, -0.5, 1.0);
    HC_Include_Segment ("?car");
    HC_Orbit_Camera (0.0, 90.0)
  HC_Close_Segment( );

  HC_Open_Segment ("perspective");
    HC_Set_Window (—0.5, 1.0, -0.5, 1.0);
    HC_Include_Segment ("?mirror wall");
    HC_Insert_Spot_Light (position, target, "outer cone = 25 degrees");
    HC_Orbit_Camera (45.0, 45.0);
    HC_Zoom_Camera (0.7);
    HC_Set_Rendering_Options ("technology=ray-trace")
  HC_Close_Segment( );
  HC_QSet_Camera_Projection ("*view", "orthographic");
HC_Close_Segment( );

HC_Pause ( );
```

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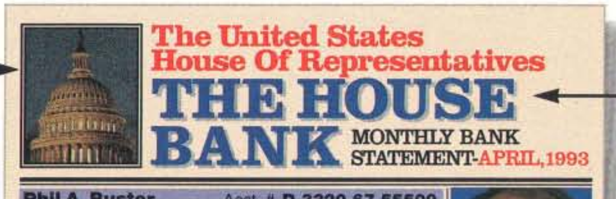

The United States
House Of Representatives
THE HOUSE
BANK MONTHLY BANK
STATEMENT-APRIL,1993

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Campaign Slogan: **"A Vote For Buster Is A Vote For Me"**

YTD SUMMARY	AMOUNT
Total Number of Bad Checks	6014
Average Daily Balance	-$41,449.00
Average Amount of Bad Checks	$19,242.00
Largest Overdraft	$49,650.00
Outstanding Loans	$85,320.00
Overdraft Fees (Waived)	$1,250.00
Interest Owed (Waived)	$5,360.43

ACTIVITY SUMMARY

Date	No.	Memo/Category	Payment	Deposit	Balance
3/17	5261	The Watergate Hotel	1,526.38		-25,623.00
3/21	5262	The Hair Club For Men	21,530.00		-47,153.00
3/28	5263	Club Med	3,850.79		-51,003.79
4/7	5264	Larry's Lexus Dealer	49,650.00		-97,653.79
4/15	5265	Burning Tree Country Club Annual Dues	10,000.00		-107,653.79
4/17	5266	American Express	23,400.09		-131,053.88

PREVIOUS BALANCE	$25,623.00	TOTAL PAYMENTS	$0.00
NEW BALANCE	$131,053.88	AMOUNT DUE	$0.00

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Bill Overdu
VP, Bounced Checks Dept.

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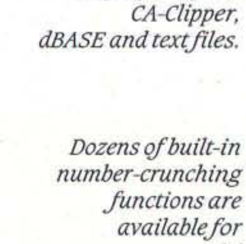

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the four camera views are mapped to these screen windows.

`Pause` instructs the system to display the current graphics database and wait for user input. After an input event—such as a mouse click—happens, the program exits. The result of the program is in the screen on page 125.

HOOPS can work as an API layered above, say, PEXlib, a low-level subroutine interface to the PEX protocol. (PEX offers 3-D extensions to X Window System.) Not least of the benefits of using HOOPS in this context are simplicity and parsimony; drawing an initial line directly in PEXlib requires *six pages* of code. While coding directly in PEXlib gives you more control than in HOOPS, it's tedious and detailed and yields a program that must be rewritten for each different platform.

Qualities

The HOOPS documentation has plenty of useful examples and is easy to use as a reference. But it's not the documentation that makes HOOPS easy to learn; it is the consistency of operation of the routines. You learn the template, as it were, so that even before you know the names of the calls by heart, you know what ought to exist—and when you look for it, there it is.

Under what circumstances would you not use HOOPS? Very few. HOOPS might not be appropriate if your application is very small and easy to program and if memory is a concern—the HOOPS DLL for Windows, for example, takes about 1 MB—or if you are working with exotic hardware unknown to Ithaca.

About the Product

HOOPS 4.0...$4200 per seat per platform
Ithaca Software
1301 Marina Village Pkwy.
Alameda, CA 94501
(510) 523-5900
fax: (510) 523-2880
Circle 1078 on Inquiry Card.

Ithaca Software, a division of Autodesk, employs 15 programmers. It is a sign of the times that many of its customers, such as Computervision and Altium (formerly CADAM), are head-on competitors of Autodesk in the CADD arena, but this does not seem to trouble anyone. Tight security is maintained so that the confidentiality of Ithaca's many developers vis-à-vis Autodesk and one another is assured. ■

Joel Orr (Virginia Beach, VA) is an internationally known CAD/CAM and computer graphics consultant. He is a founding member and past president of the National Computer Graphics Association. You can reach him on BIX c/o "editors" or on the Internet at 0004153485@mcimail.com.

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Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
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Business	25
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57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
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77	103	129	155	181	207	233

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234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
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258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 591-765

591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
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Low-Priced Pentium PCs

In spite of high CPU costs, Pentium system prices are coming down

ED PERRATORE

Now that Pentium-based PCs are hitting the market in force, the next natural step is lower prices. Gateway 2000 took that step first by offering a complete configuration of its P5-60 Pentium system for just under $3000. Other vendors are not far behind, so buyers of these first inexpensive Pentium systems are not without choices for an Intel-based graphics workstation or low-end file server. For this roundup, BYTE asked for the most souped-up system the vendors offered beneath a $4500 price ceiling.

Affordable, full-featured Pentium systems *from (left to right) Ambra Computer, Gateway 2000, and Advanced Logic Research.*

The three systems I reviewed—Advanced Logic Research's Evolution V, Ambra Computer's Ambra DP60E/VL, and Gateway 2000's P5-60—deliver generally robust performance aided by local-bus architecture. The ALR system also had a caching IDE pass-through card that greatly boosted applications performance.

ALR's Evolution V is an ISA, VL-Bus desktop system that, for $4314, comes with 16 MB of RAM, a 420-MB IDE hard drive, an IDE card with 1 MB of cache memory, a Western Digital VL-Bus graphics accelerator card, and an ALR ClearView 15 monitor. Ambra's $4399 EISA desktop offers 16 MB of RAM, a 540-MB SCSI-2 hard drive with a 256-KB cache/buffer, an ATI graphics accelerator card running in a VL-Bus slot, and a 15-inch monitor.

Gateway weighed in with the only PCI (Peripheral Component Interconnect) machine, an ISA tower model with 16 MB of RAM, a 528-MB IDE hard drive, an ATI PCI graphics accelerator card, and a 17-inch CrystalScan 1776 LE monitor. With a Mitsumi CD-ROM drive added to my test model, the Gateway costs $3995.

All three systems came with DOS and Windows installed. The Gateway P5-60 also included Central Point Software's PC Tools for Windows and, on a CD-ROM disc, backups of the preinstalled software.

ALR Evolution V

ALR typically sells its PCs through vertical-market VARs, who may configure the bare-bones Evolution V Model 1 with a hard drive and graphics card appropriate for the customer. For the system that I reviewed, ALR's choice of video adapter alternately raced and jogged, depending on the test. The Evolution V also fell short of the other two systems in color capability: It offered a maximum of 16-bit color at 800- by 600-pixel resolution, while the competing machines offered 24-bit color at that resolution. (I ran graphics performance tests on all the systems with 8-bit color at 640- by 480-pixel resolution.) Other than the WD90C33-based graphics accelerator card, which a CAD/CAM user might want to pass over in favor of a higher-end card, there is not much to criticize about the Evolution V.

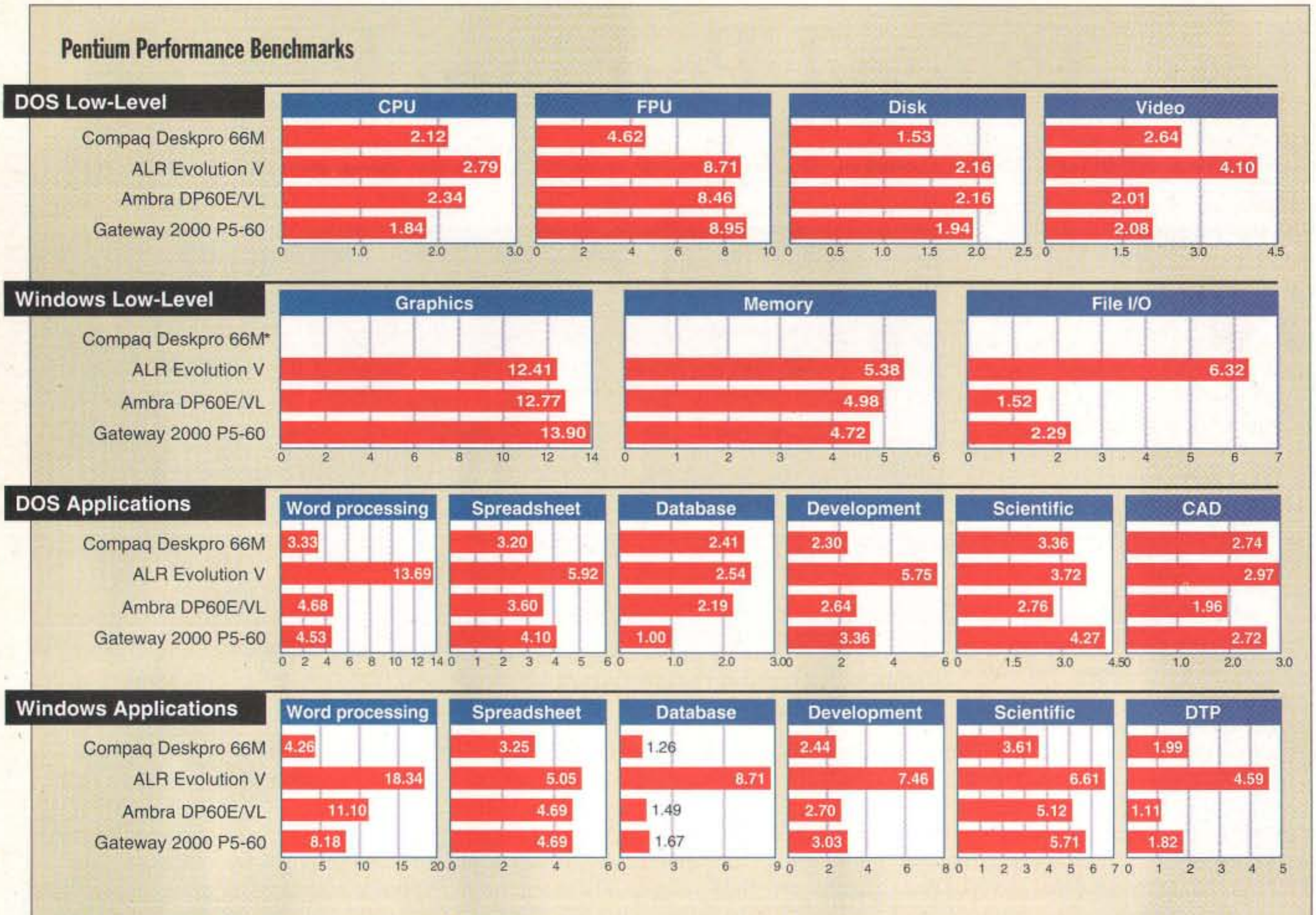
The desktop system's sturdy case holds a 3½-inch floppy drive and three exposed 5¼-inch drive bays. Secured by two finger-turnable screws, the case is easy to remove. A printed chart inside the case lists bank-by-bank memory configurations up to the maximum 128 MB (using 32-MB SIMMs, which ALR promises it can supply).

Populating the motherboard are the 60-MHz Pentium CPU (cooled by an extra fan in the system's front panel as well as a top-mounted heat sink), 256 KB of secondary memory cache (the maximum), a Phoenix BIOS, Chips & Technologies and Opti chip sets, and six 16-bit ISA slots. Three of the slots have VL-Bus extenders. The Super VGA card sits on the VL-Bus, as does the caching IDE card, which is able to accommodate up to 16 MB of cache RAM.

The ALR-made motherboard also has IDE and floppy drive connectors, but the optional caching IDE pass-through card is a wise choice if you're concerned about disk performance. The IDE board's write-back cache is optimized for Windows. The cache gave the Evolution V an outstanding disk index in the BYTE Lab's Windows benchmarks and largely accounts for the Evolution V's lead in the DOS and Windows application benchmarks. One thing to keep in mind, however, is that installing a good local-bus disk cache in the Gateway and Ambra systems might well even the score.

In low-level video testing, the Evolution V's performance was roughly double that of the competition. But in the more real-world Windows benchmarks, the system proved superior only in drawing pixels and performing BitBlts, often falling well behind in drawing lines, rectangles, and ellipses. The Western Digital board comes with only 1 MB of VRAM (video RAM), half what the two ATI boards came with, but it can hold 2 MB.

If what you want from the system is a file server, you're bound to be disappointed by the Evolution V's 200-W power supply, six expansion slots, and total of six drive bays. A better choice would be ALR's Evolution V-Q, which BYTE tested in our look at the first Pentium systems out of



*The Compaq Deskpro 66M did not run the Windows low-level benchmarks.

All results are indexed, and higher numbers indicate better performance. For each test, a Compaq Deskpro 386/33L running DOS 5.0 and Windows 3.0 = 1. Current test systems ran DOS 6.0 and Windows 3.1. The Compaq Deskpro 66M (66-MHz 486DX2, 16-MB RAM, 256-KB memory cache, Compaq QVision video, and 510-MB IDE hard drive) was tested for comparison.

For a complete description of the tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks (version 2.4) are available in the byte.bmarks conference on BIX or by contacting BYTE directly.

The ALR Evolution V *provides the best overall applications performance, mainly because of its caching IDE drive card—something you could add to the other systems. However, its good low-level performance gives it an edge in processor-intensive tasks regardless of peripheral configuration. Note the strong floating-point performance of the Pentium systems relative to the 66-MHz 486 Compaq, included for comparison.*

the gate (see "Pentium PCs: Power to Burn," July 1993 BYTE). That machine features a 128-bit-wide data path to system memory, a tower case, 10 EISA slots appropriate for connecting lots of fast mass-storage devices, and 13 exposed drive bays. The Evolution V-Q also costs nearly $2000 more than the Evolution V in a similar configuration.

And if what you want is PCI rather than VL-Bus in a Pentium system, ALR expects to soon ship the Evolution V STP, in 60- and 66-MHz versions. The former will start at $3410 for an 8-MB system with DOS and Windows but no hard drive or monitor. Both versions will include a single-channel integrated Fast SCSI-2 controller as well. The PCI bus allows concurrent operation by the CPU and PCI peripherals, something VL-Bus doesn't yet allow.

Ambra DP60E/VL

The 22-pound Ambra DP60E/VL seems to use only as much steel as necessary to support the 55-pound weight of Ambra's largest monitor. Yet the mostly plastic case not only is sturdy, it also removes without screws and can be converted to a mini-tower.

Inside you'll find some attractive features. Among them are an Adaptec AIC-7770P Fast SCSI-2 dual-channel chip set and connector that let you hook up as many as 14 SCSI devices; an Acer/Ambra-designed BIOS; and six EISA slots, two with VL-Bus extensions. An Opti chip set is spread between the motherboard and the CPU daughtercard, which also holds the external memory cache. The 16 MB of RAM is upgradable to 64 MB (actually 128 MB by design, but Ambra cannot guarantee shipment of 32-MB SIMMs any time soon). My test model also came with a Seagate ST3610N SCSI-2 drive with 256 KB of on-board, write-back cache.

What I found less appealing were a few corners Ambra cut in its mission to deliver lower-priced systems than you'll ever see from parent company IBM. The design of the daughtercard housing the processor and secondary cache is worrisome; a plastic clip is all that holds it down tight. If I wanted to, say, upgrade the external cache from the standard 256 KB to the maximum 1 MB—or merely to leave it alone—I would prefer additional support in case the plastic fatigues.

The 3½-inch floppy drive has no spring-loaded dust cover, which I discovered does more than just keep out dust: It also prevents ejected floppy disks from flying across the keyboard. In addition, I discovered a jumper wire connecting two sites

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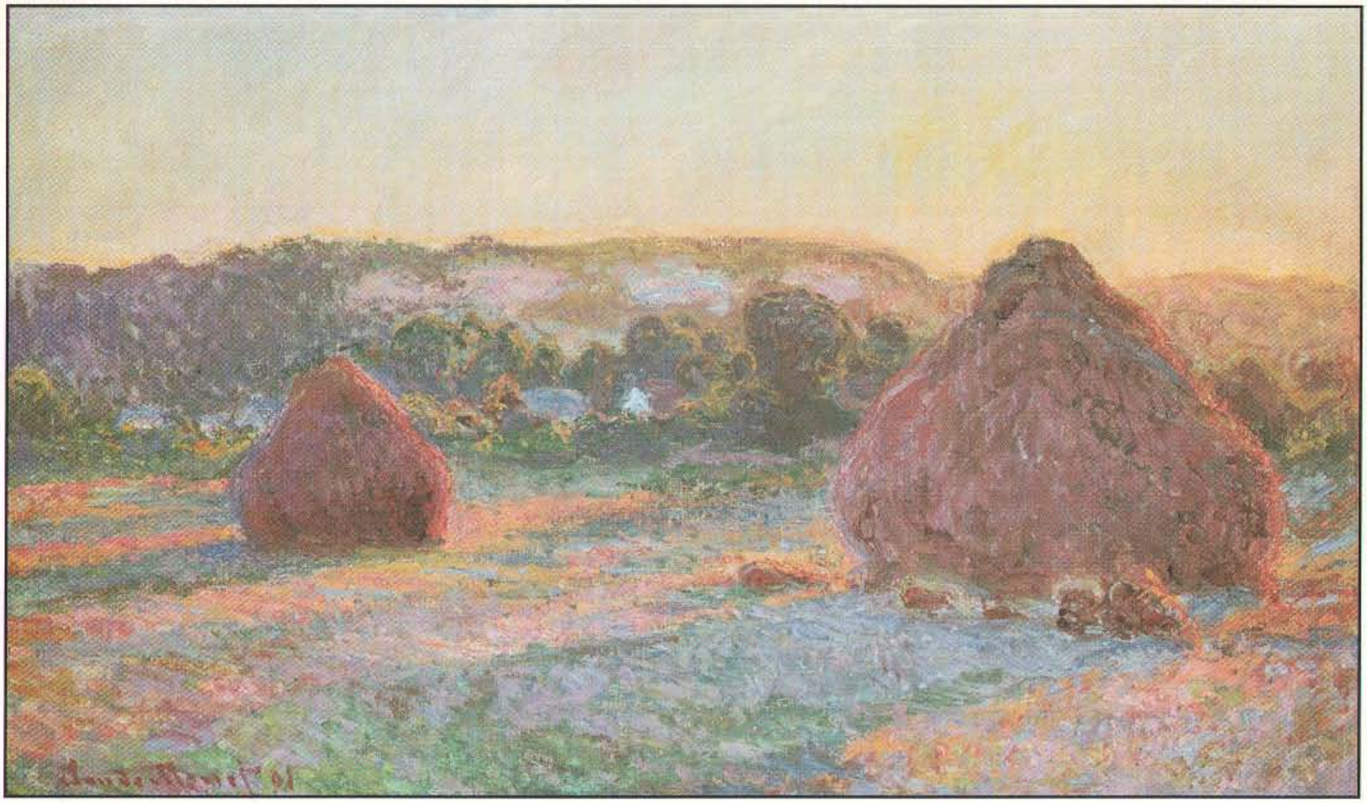

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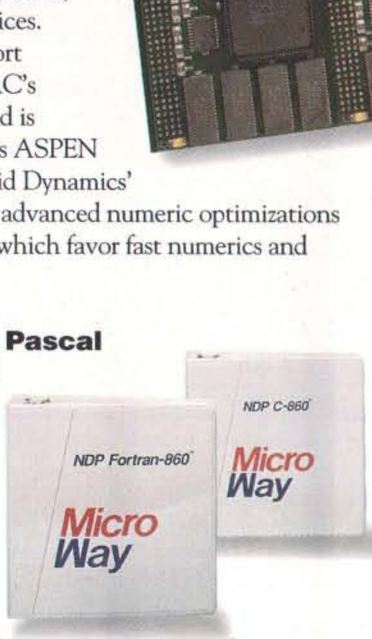

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60-MHZ PENTIUM SYSTEM FEATURES

Gateway wins the features and price war, offering a 17-inch monitor, CD-ROM drive, and PC Tools for under $4000. Although the ALR and Ambra systems come with smaller 15-inch monitors and higher price tags, the ALR Evolution V has a performance-boosting 1-MB caching IDE card and the Ambra has a capable SCSI-2 hard drive. All the reviewed systems have local-bus graphics cards.

Pentium System Features	ALR Evolution V	Ambra DP60E/VL	Gateway P5-60
System memory (as tested/max)	16 MB/128 MB	16 MB/64 MB*	16 MB/128 MB
Memory cache (as tested/max)	256 KB/256 KB	256 KB/1 MB	256 KB/256 KB
Processor-to-memory data width (bits)	64	64	64
Expansion bus	ISA/VL-Bus	EISA/VL-Bus	ISA/PCI
Storage	420-MB Western Digital Caviar 2420 IDE	540-MB Seagate ST3610N SCSI-2	528-MB Western Digital Caviar 2540 IDE
Graphics	Western Digital VL-Bus graphics accelerator with 1 MB VRAM	ATI VL-Bus graphics accelerator with 2 MB VRAM	ATI PCI graphics accelerator with 2 MB VRAM
Display	15-inch multiscan color monitor	15-inch multiscan color monitor	17-inch multiscan color monitor
Other features	DOS, Windows	DOS, Windows	Double-speed CD-ROM drive, DOS, Windows, Central Point Software PC Tools
Price as tested	$4314	$4399	$3995

* The Ambra DP60E/VL will be expandable to 128 MB when 32-MB SIMMs become available from Ambra Computer.

on the daughtercard—not something you want to see on any PC, let alone on a Pentium system.

Test results show that the Ambra trailed the Gateway system somewhat on most application benchmarks, and both fell behind the ALR system. Using an ATI VL-Bus graphics accelerator card with the same Mach32 chip set and 2-MB VRAM that the Gateway's PCI card had, the Ambra achieved Windows performance similar to that of the Gateway. In the DOS dBase IV database application test, however, the Ambra just about doubled the performance of the Gateway. The Ambra also led the Gateway slightly in word processing tests.

If it had been available in time, the better selection for this head-to-head comparison might have been the PCI version of this system, which Ambra announced on November 15 of last year. A 60-MHz system with 8 MB of RAM (upgradable to 128 MB), a 440-MB hard drive, Diamond Viper's PCI graphics accelerator with 2 MB of VRAM, a CD-ROM drive, and a 15-inch flat-square monitor will cost you $3499.

Gateway P5-60

Despite performance that falls behind that of the ALR system, the Gateway P5-60 offers the most features for the price. In addition to its PCI architecture, CD-ROM drive, and extra software, the system also came with the best monitor. The Gateway CrystalScan 1776 LE is a 17-inch monitor offering a 0.26-mm dot pitch, a 32-character LCD panel displaying the current display mode, and Macintosh D-sub and BNC connectors in addition to a standard 15-pin Super VGA connector. This monitor is also the only one of the three with a detachable signal cable.

Inside the heavy-duty tower chassis is an Intel/AMI motherboard with its Pentium chip housed in a ZIF (zero insertion force) socket for future upgradability. An extra front-mounted fan pulls heat off the CPU's heat sink. The P5-60 uses Intel's Pentium/PCI chip set to support three PCI expansion slots in addition to five 16-bit ISA slots; one is a shared ISA/PCI slot. Eight drive bays provide plenty of storage expansion. The ATI PCI video adapter gave the system an edge in drawing lines, rectangles, and ellipses in BYTE's Windows benchmark test.

The Western Digital Caviar 2540 IDE drive, running directly off the motherboard, scored twice as high as the Ambra's Seagate on the BYTE Windows benchmarks' sequential file I/O test, and about 17 percent higher on the random I/O test, although it trailed the Ambra's disk subsystem in the low-level DOS tests. Windows

WHAT'S ANGUS SAYING?
See Page 175

disk performance may have given the Gateway system a slight edge over the Ambra in several of the Windows application tests. Note that the P5-60 supports fast DMA transfers—good for sequential I/O—but the built-in 256-KB cache in the test-model Ambra's SCSI hard drive was double that of the Western Digital IDE drive that came with the P5-60.

The P5-60 produced a low CPU index on the DOS low-level benchmark because of its relatively slow memory system and the considerable weight that is placed on memory performance by the benchmark test. Because of this weighting, a Compaq Deskpro with a 66-MHz 486DX2 actually achieved a higher CPU index than the Gateway Pentium system did.

However, the P5-60's "memory effect" lessened in the Windows low-level memory test and essentially disappeared in the applications tests. In most applications tests, the P5-60 actually had a slight edge over the Ambra, reflecting the relative merits of the systems' hard drive and video subsystems more than memory performance differences.

Like the Ambra, the P5-60 showed a couple of design quirks. The first was a patch wire running a good 6 or 7 inches across the motherboard and indicating a product rushed to market. The second was an overnight language switch, from English to French, of the "Non-System disk or disk error" message you get when there is an unbootable floppy disk in the drive at power-on. Both the Ambra and Gateway systems I reviewed were among the first off the production line, and the kinks should disappear by the time you read this.

Performance a Tough Yardstick

What may be most important about my benchmarking of the ALR, Ambra, and Gateway Pentium-60 machines is that, by and large, differences in speed can be attributed more to configuration—the amount of disk cache or VRAM, for example—than to actual motherboard design. But when you factor in the care taken in design and manufacturing in this first wave of relatively low-cost Pentium systems, the choice becomes a bit easier. For high-end graphics or a small file server, I'd opt for peace of mind and go with the more mature ALR Evolution V. ■

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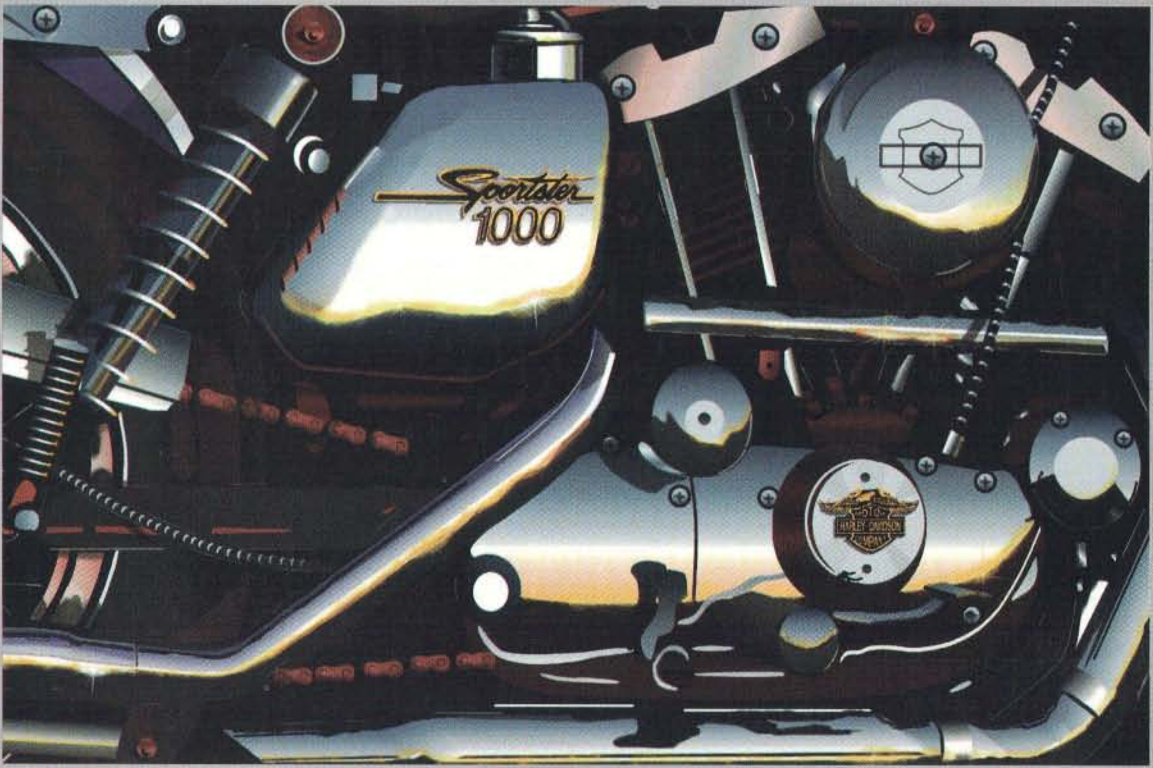

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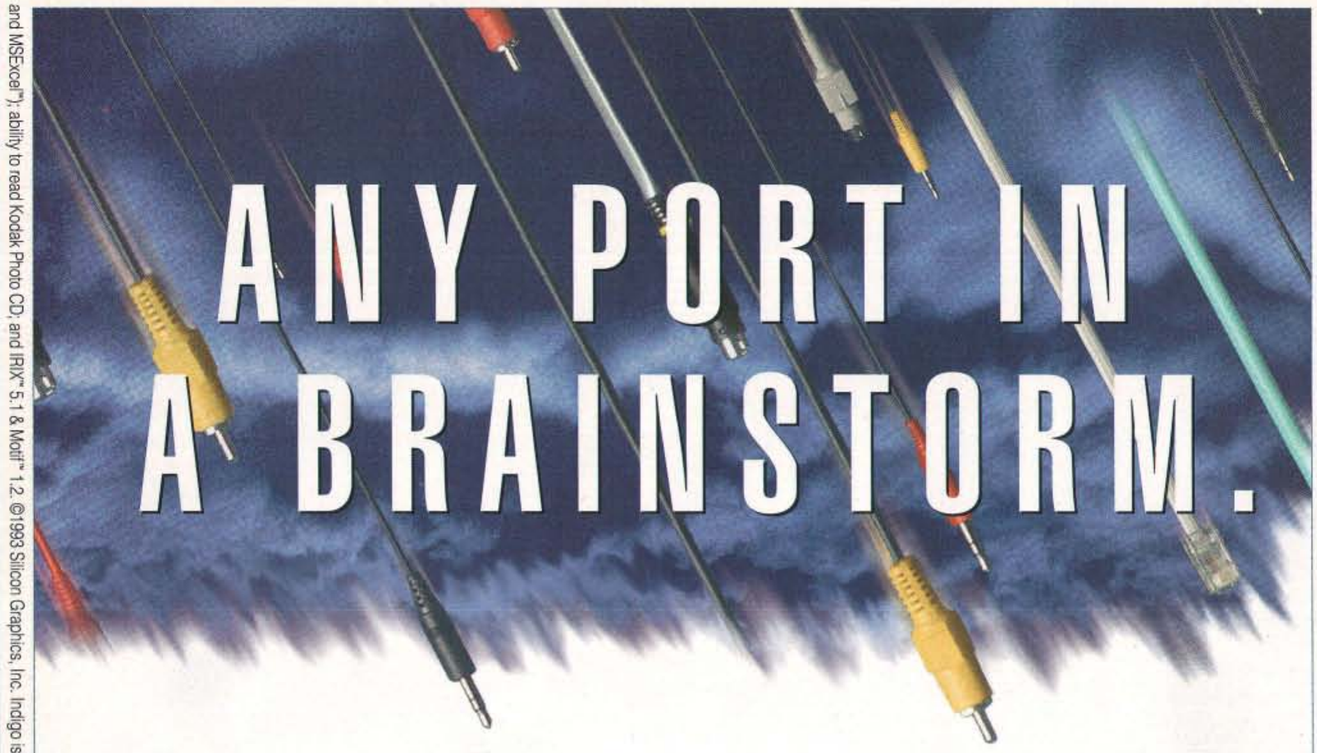

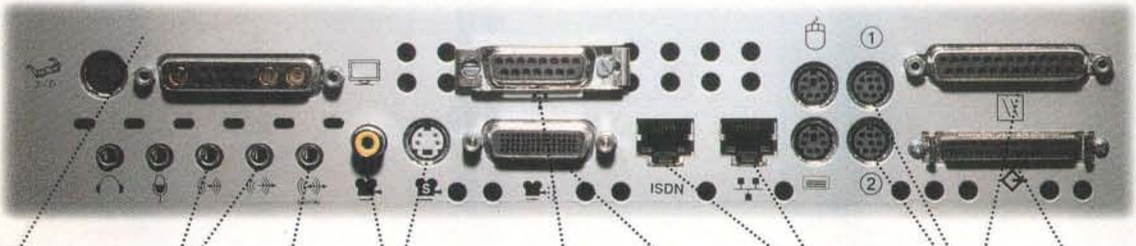

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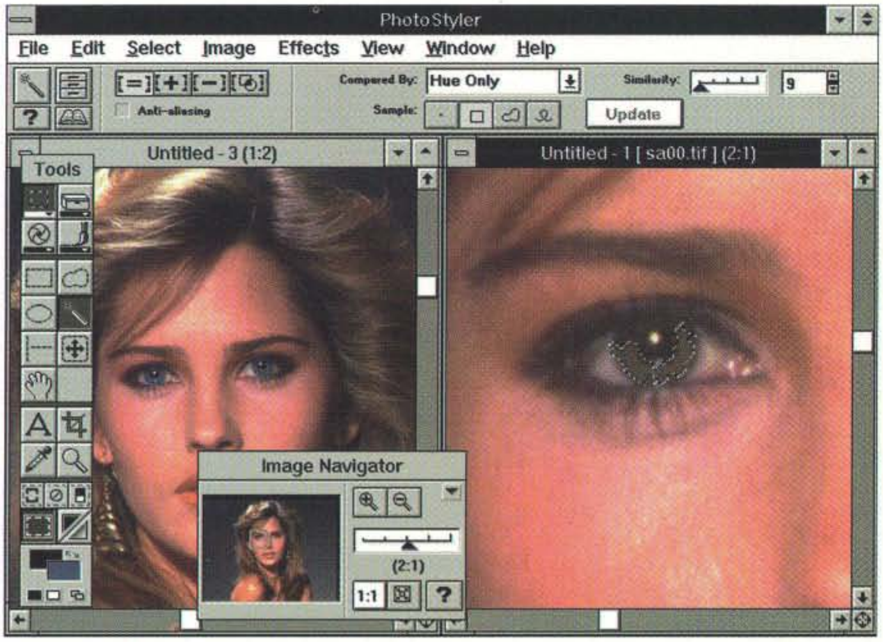
PhotoStyler Fights Back

Aldus closes the Photoshop gap with the release of PhotoStyler 2.0

HOWARD EGLOWSTEIN

Ask anyone who does serious image processing on a personal computer: Adobe Photoshop for the Macintosh has been the undisputed king of the image editors for quite some time. Aldus is hoping to dethrone the Mac/Photoshop environment with the latest release of PhotoStyler. Like the Windows version of Photoshop, PhotoStyler 2.0 gives you full control over your images, providing scanner and printer support, conversion to many output formats, and just about every image manipulation control you might want.

PhotoStyler went through much more than a face-lift going from version 1.1 to version 2.0. Most of the new features either improve the package's performance on large images or give you better control over the final output. Aldus's philosophy in making all these changes was to eliminate the trial-and-error work that often goes into editing. If you're working with a 25- or 50-MB image, you don't want to wait for the system to catch up while you scroll through the image. And if you're adjusting the color balance of a freshly scanned image, you don't want to watch an hourglass while the system calculates the effect on 25 MB of data.



PhotoStyler 2.0 *showing multiple document windows, the Image Navigator (for moving quickly around large images), and the enhanced magic wand selection. The image is from Corel's Professional Photos CD-ROM series sampler.*

A Sum of the Parts

The screen above shows a sample image from Corel's Professional Photos CD-ROM series. The model shot was part of an 18-MB Photo CD image. Loading the image into memory from a CD-ROM, especially an older standard-speed (150-Kbps) CD-ROM reader, takes quite a while.

PhotoStyler lets you crop out and just read part of an image as it loads, or you can select the Partial Edit feature. Partial Edit lets you select a region of the larger image to bring into memory while the rest of the image remains on disk. After making changes to this section, PhotoStyler puts it back exactly where it came from.

The old days of zooming in and out on an image to see where you are or to find a particular spot are gone, too. The Image Navigator provides a thumbnail view of the entire image, with a small gray box showing the current window selection. Simply move the box to the area you're interested in or select a new zoom factor from the handy slider.

The idea of working with thumbnails and previews extends throughout the product. For most commands, you can choose to preview the effect on a small thumbnail before committing it to the whole image. The screen on page 138 shows the Color Balance tool applied to a digital image I shot with a Kodak DCS200 digital camera. The image on the left is the original photo as read from the camera. The other two boxes show the effects that two different settings have on the image.

There's a bit of yellow cast on the image because the sun was beginning to set. In Test 1 (center), I shifted the image slightly toward blue to correct for the yellow. That setting took too much warmth out of the old wooden railing, so I switched to Test 2 (right) and tried another version. This time I chose to have the correction apply only to the highlights and applied a bit more correction. The sample shows the screen just after updating Test 2. I could then preview the entire image or apply the change permanently.

Like Magic

PhotoStyler has some sophisticated new tools for selecting image areas. The editing in progress in the screen above shows one such tool enhancement—the magic wand. This feature, shared by most other image editors, lets you select a distance in color space and a point on the image and proceeds to select all adjacent pixels that lie within that color range. That works, but here I wanted to change the model's hazel eyes to blue. The center of her eye and the highlights were not green, but neutral in color. I wanted to select all the green portions without getting any of the dark gray.

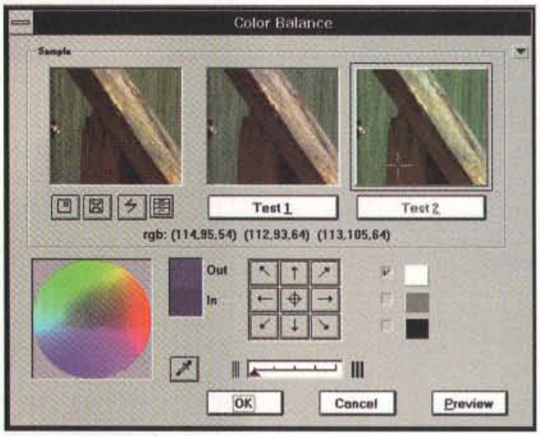
The right side of the screen shows the effect of putting the wand in hue-only mode. Instead of picking up any color that is more or less the same intensity, the hue wand requires that all pixels have the same basic color. The similarity adjustment takes care of selecting the range of green pixels.

The selected area in the photo is just the first selection. I then extended the selection to include some of the darker areas and used this as a mask to protect the white and center of the eyes from a paint-can

PHOTOSTYLER PERFORMANCE

PhotoStyler 2.0 performs admirably against Photoshop on the Windows platform. All tests were run on a 33-MHz 486 machine with 24 MB of RAM. A dedicated 340-MB SCSI drive stored the images and provided virtual memory swap space. PhotoStyler ran with Windows' virtual memory enabled; Photoshop generally runs faster if you disable Windows' virtual memory and allow Photoshop to handle the virtual memory itself. Both test images were uncompressed TIFF files. Times are in minutes:seconds.

	LOAD 6-MB FILE	SHARPEN 6-MB FILE	SAVE 6-MB FILE	LOAD 26-MB FILE	SHARPEN 26-MB FILE
Photoshop 2.5	0:22	0:20	0:21	3:36	5:39
PhotoStyler 2.0	0:14	0:27	0:19	1:38	5:53



An example of PhotoStyler's *preview windows. For most effects, PhotoStyler displays the original image and two practice or test areas. You apply the effect to these thumbnails to see what the final effect will be when you apply it to the entire image. Having two test areas lets you compare two possible effect settings.*

fill. On the paint can, I used the hue-only fill and flooded the eyes with blue. The image on the left of the screen on page 137 shows the result. By contrast, Photoshop's wand uses only RGB color-space distance and doesn't have the flexibility of PhotoStyler's wand.

Device Support

Rather than trying to support every conceivable input device, PhotoStyler uses TWAIN, an industry-standard Windows driver, as its basis for scanner support. Using the Epson-supplied TWAIN driver, I had no trouble getting PhotoStyler to recognize my Epson ES-300C scanner.

The only difficulty I had was in scanning large images. With the latest Epson TWAIN driver, PhotoStyler couldn't scan in any image much larger than 6 or 7 MB; the software reported that it couldn't allocate sufficient memory for the scanning process. I called Aldus's technical support and found that, because the product was so new, the company hadn't had a chance to test PhotoStyler with the Epson TWAIN driver that I was using (version 1.02E). Aldus is working with Epson on the problem. Scanning with other TWAIN sources is supposed to work just fine.

In the meantime, Epson owners will have to be content with smaller scans or use the proprietary Epson driver that came with PhotoStyler 1.1a. The older driver is available directly from Aldus if you don't have the older version of the program. Neither Photoshop nor Picture Publisher had any trouble scanning a 25-MB test image using Epson's TWAIN driver.

On the output side, PhotoStyler uses Kodak's Precision Color Management System to match your screen to the intended output device. CMS installs as a Windows Control Panel to select your monitor, input device, and output device from a menu of known devices. PhotoStyler uses CMS to map all colors to your monitor for display and adjusts the color coming in from your scanner. To make sure you don't create something you can't print, CMS also changes your screen display to match the color gamut, or range, of your printer or print process.

Kodak's CMS is new and doesn't support many devices yet. My system configuration included a standard NEC MultiSync monitor, the Epson 300C scanner, and Kodak's ColorEase dye-sublimation printer. CMS supports neither my scanner nor my printer, and the monitor selection is limited to two standard phosphor types. More device support should be forthcoming from Kodak and device manufacturers as CMS becomes more of a standard.

If you're working on one output type but plan to use the images on a different type, the Soft Proof option lets you see how the output will look. For example, you may be using a dye-sublimation printer but planning to use the images in a four-color printed brochure; Soft Proof adjusts the colors on your monitor to reflect how the image will appear after going through the printing process.

The Price of Power

There's a price to pay for this power, and I'm not just referring to the $795 retail price tag on the box. I did this review on a seriously hopped-up 33-MHz 486 with 24 MB of RAM, a 24-bit display card, and about 1 GB of disk space. The 486 was poky handling images larger than 10 MB, and PhotoStyler didn't like editing images much larger than physical free memory.

Aldus recommends at least 8 MB and a 33-MHz 486, but for serious editing work you'll want the biggest, fastest machine you can get. I ended up clearing space on a 340-MB SCSI drive to make room for PhotoStyler's temporary files.

To be fair, Photoshop claims to run on any 486 with 8 MB of RAM, but Photoshop and PhotoStyler ran at about the same speed on my machine. If I were planning to use either package for serious prepress image editing, I'd want at least a 50-MHz 486DX or 66-MHz 486DX2 machine with 32 MB of RAM and a huge hard drive.

This review also pointed out one reason the Mac is still the most popular image-editing environment: Windows isn't very good at handling *big* programs. Several times, I got unrepeatable, unrecoverable memory errors and protection faults. I checked with Photoshop users and found that my experience wasn't that unusual. For my tastes, Windows simply isn't stable enough to use as a primary image-editing platform. I've been using PhotoStyler 1.1 since it came out, to scan images with my Epson scanner, but these are usually small enough (less than 1 or 2 MB) to save often.

PhotoStyler 2.0 is a major improvement over 1.1. The emphasis is on providing powerful tools to get you to the right part of the image and make the right changes the first time, without time-consuming trial and error. I'm a registered user of 1.1, and I was planning to abandon PhotoStyler for Adobe Photoshop, but now I probably won't. If you've got the iron to run it, PhotoStyler 2.0 is a world-class image-editing/retouching package. ■

About the Product

PhotoStyler 2.0 ......$795
Aldus Corp.
411 First Ave. S
Seattle, WA 98104
(206) 628-2320
fax: (206) 343-3360
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Howard Eglowstein is a testing editor for the BYTE Lab. You can contact him on the Internet or BIX at heglowstein@bix.com.

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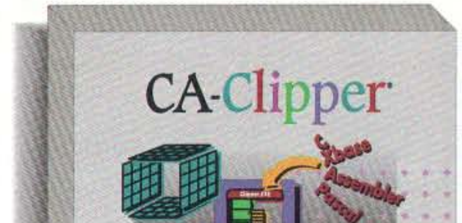

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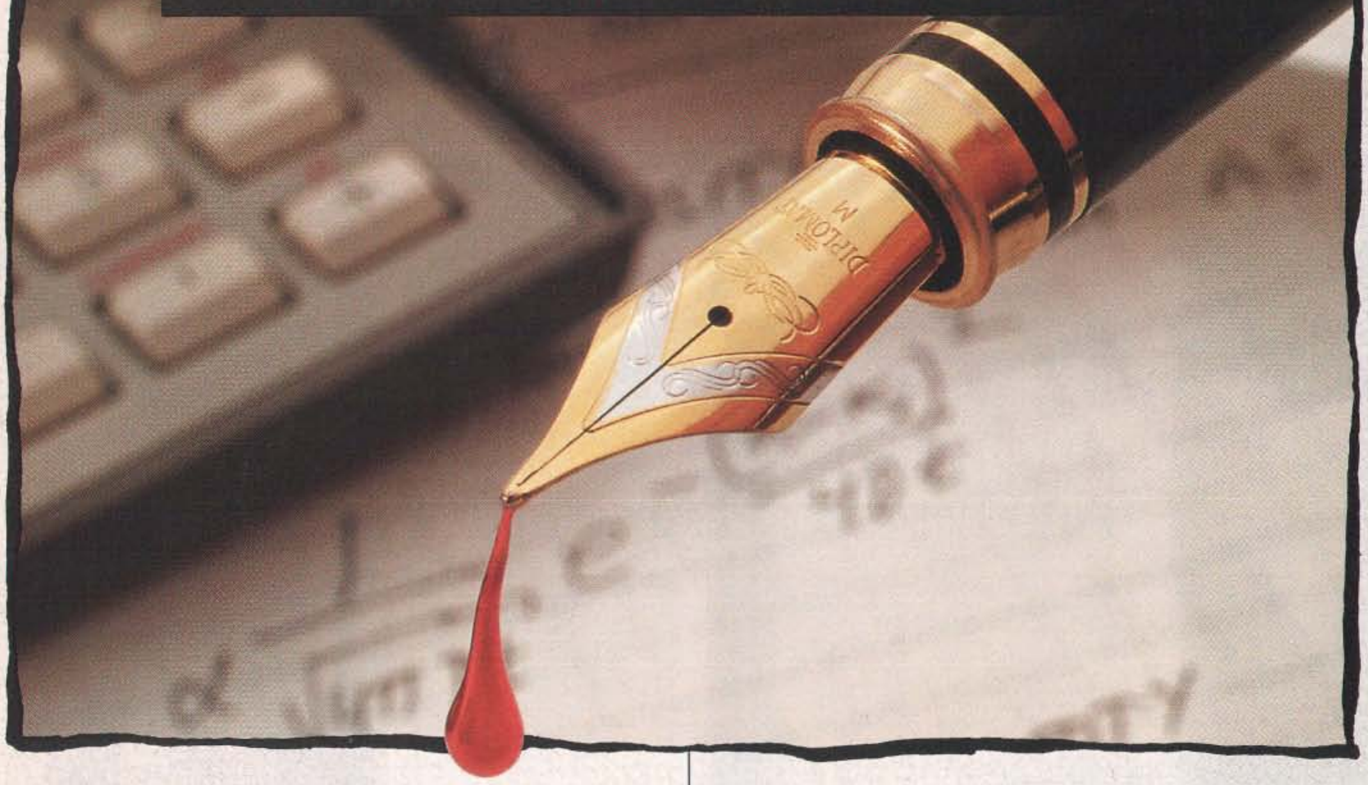

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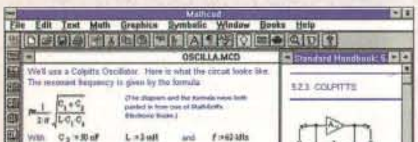

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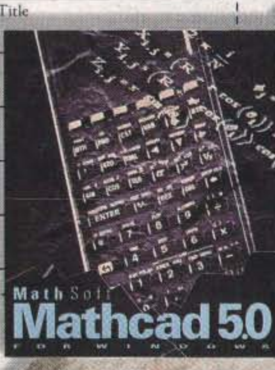

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WinFax Pro Hits the Network

Delrina's Windows fax package offers workgroups easy access to shared modems and room to grow

STAN MIASTKOWSKI

For good or ill, faxes have become a fact of life. But in a small business or corporate environment, equipping every computer with its own fax modem can mean installation and support nightmares; and then there's the cost of a fax-dedicated telephone line for each user. So, having one or more centralized fax modems connected to a LAN has become an attractive alternative. Unfortunately, the network fax software market waters have been more than a bit muddy.

At the high end of the market are products like Castelle FaxPress and Intel Net Satisfaxtion, which can cost $2000 or more and are designed for large networks and high fax traffic. Some products in this class require proprietary hardware and an experienced network guru to install and maintain the system. Early forays into the low-cost end of the market, such as the initial version of Nuko Information Systems' Message Port, offered a low price but limited features. That's changing, as exemplified by WinFax Pro for Networks, as well as by updates of Message Port and lower prices on other packages (see the text box "Other Faxes Received").

A Familiar Face

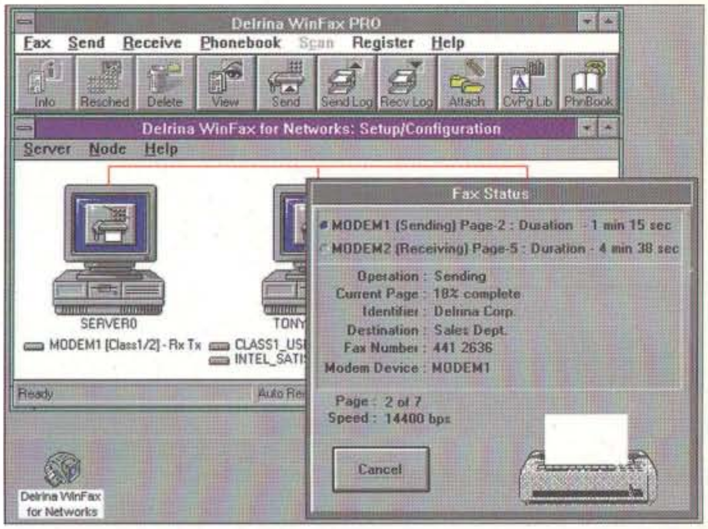
WinFax Pro for Networks has an advantage over other low-cost network fax packages, in part because it is built around WinFax Pro 3.0, one of the industry's best-selling Windows fax software packages since its introduction in 1990. WinFax Pro for Networks adds the "hooks" necessary for network use but retains the original product's ease of installation and use. The network version also retains the core set of WinFax Pro features, including the ability to send faxes directly from any Windows application and combine documents from multiple applications into a single outgoing fax. There's a phone-book utility that can be shared over the network, as well as fax annotation and forwarding and a full-featured cover-page designer. You can also schedule fax transmissions for low-phone-rate hours, as well as broadcast individual faxes or groups of faxes to many recipients automatically.

For $399, WinFax Pro for Networks provides a server component (both DOS and Windows versions) and two network client packages. Each server can support up to four fax modems. For a small office environment or a small workgroup in a corporation, that's a logical and inexpensive way to get started.

Scalability sets WinFax Pro apart from its low-cost fax-modem-sharing software competitors. As fax requirements evolve, you can add to a WinFax Pro for Networks installation in a building-block fashion. Any workstation on the network can be a WinFax Pro for Networks server. Additional server packages cost $179 each. Client software ranges from $99.90 per seat for a 10-user license to $85.98 each for a 50-user license. Existing WinFax Pro 3.0 users can upgrade to WinFax Pro for Networks clients for free: You call Delrina for a new serial number that makes your copy of WinFax Pro 3.0 network-aware. There's a limit of four servers (up to 16 fax modems total) in any one WinFax Pro for Networks workgroup, and an absolute limit of 255 users.

Getting On the Network

WinFax Pro for Networks works on any IPX- or NetBIOS-based DOS network. This includes the usual list of popular server-based and peer-to-peer LANs, including Novell NetWare, Artisoft LANtastic, and Microsoft Windows for Workgroups. Because of the way it uses the network, WinFax Pro for Networks works equally well with both types of LANs. Any station can be the WinFax Pro for Networks server as long as it has a common drive accessible to WinFax Pro for Networks clients. For example, using the DOS version, you can turn an "obsolete" 286-based system into a capable WinFax server. (After all, pumping data to and from telephone lines doesn't exactly require Pentium-level processing power.)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MODEM1 [Class1/2] - Rx Tx
TONY
CLASS1_USI
INTEL_SATI
Ready
Auto Re
Delrina WinFax for Networks
Fax Status
Cancel

MODEM1 (Sending) Page-2 : Duration - 1 min 15 sec
MODEM2 (Receiving) Page-5 : Duration - 4 min 38 sec
Operation : Sending
Current Page : 18% complete
Identifier : Delrina Corp.
Destination : Sales Dept.
Fax Number : 441 2636
Modem Device : MODEM1
Page : 2 of 7
Speed : 14400 bps

Except for the multiple modem-status lines *at the top of the Fax Status Screen, using WinFax Pro for Networks is virtually identical to using WinFax Pro 3.0. You can also see a graphical representation of networked fax resources, as shown in the background here.*

For this review, I installed multiple copies of WinFax Pro for Networks on a five-station LANtastic 5.0 network, with two stations configured as servers under Windows. One server (a Gateway 33-MHz 386) had both an internal Intel Satisfaxtion 400 fax modem and an external Microcom Deskporte fax modem. The second server (a 66-MHz 486DX2–based system) had an external ATI 14400 ETC-E fax modem. For several weeks, I used this setup for my day-to-day fax traffic, sending and receiving a variety of short and long faxes using all three modems and three different telephone lines.

Overall, WinFax Pro for Networks' performance (both imaging time and transmission time) was basically identical to that of the stand-alone version. This wasn't surprising, since WinFax Pro for Networks handles all imaging and storage locally. I simulated a heavy load by having one of the servers perform an involved database sort at the same time it was sending and receiving faxes. While performance slowed

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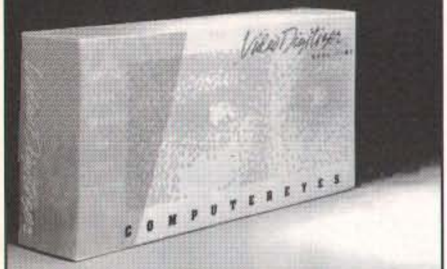

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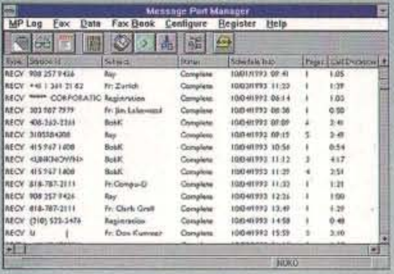
Other Faxes Received

Low-cost fax-modem-sharing software is an idea whose time has come. Here are a couple of other choices:

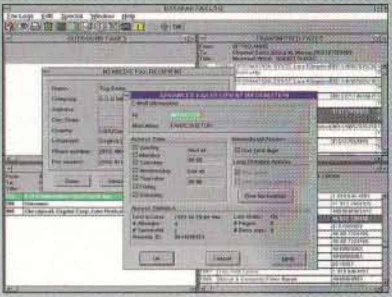


Message Port/Pro from Nuko Information Systems is the latest incarnation of Message Port, a package that does more than share fax modems on a network. It's unique in offering low-cost modem pooling, which allows data modems to be shared as well. Originally designed for Microsoft Windows for Workgroups, Message Port/Pro now supports all IPX- and NetBIOS-based LANs, so it covers nearly all PC bases.

The package was in prerelease testing at press time and unavailable for review. But I looked at an earlier version of Message Port and found it lacking some essential features, such as wide modem support and the ability to create customized fax cover pages. A company spokesperson says the new version supports all Class 1, Class 2, and CAS (Communications Applications Specification) fax modems and provides advanced features like OCR (optical character recognition). Nuko also says the product can automatically route incoming faxes by using OCR to recognize the name of the recipient. Message Port uses a true client/server approach, with all faxes stored on the server before transmission.

Modem pooling can be handy, but it may create heavy network traffic that bogs down LAN performance. Users with considerable data communications needs are often better off with their own dedicated modems.

Message Port/Pro is priced aggressively, starting at $79 for a stand-alone, non-networked version. A 10-user license is $399; 20 users, $698; 50 users, $898; and 100 users, $998.



DataFax for Workgroups from Trio Information Systems has been available for over two years and is widely used in Europe. It shines in the area of network integration, with drivers for nearly all commonly available networks. Besides the usual server-based and peer-to-peer LANs supported by the other packages mentioned here, this product also supports Banyan Vines and Windows NT Advanced Server.

DataFax for Workgroups supports nearly all fax modems. Its server component is unique: you can set it up as a nondedicated server or as a true dedicated server. As the latter, it can support up to 24 fax modems on a single PC.

Recognizing that many people use faxes mainly to send quick notes, Trio has provided a QuickFax function that lets you click on an icon and fire off a fax without having to deal with changing printer drivers. This product has the most extensive security features of the products covered here. And, for its features, it's also priced aggressively: two-user license, $249 (additional single users are $89 each); five users, $429; 10 users, $795; 20 users, $1195; 50 users, $1595; 100 users, $1895.

About the Companies

Nuko Information Systems, Inc.
1609A South Main St.
Milpitas, CA 95035
(800) 995-2166
(408) 262-2225
fax: (408) 262-2261
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Trio Information Systems, Inc.
8601 Six Forks Rd., Suite 615
Raleigh, NC 27615
(800) 880-4400
(919) 846-4990
fax: (919) 846-4997
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(as expected), it was much the same as it would have been on a non-networked system. The bottom line is that, except for the potential wait for a free fax modem, WinFax Pro for Networks is no slouch in the performance department.

WinFax Pro for Networks is one of the easiest-to-install LAN packages I've used. I had the two servers and five clients installed and running on a LANtastic 5.0 network in less than an hour. You set up the server component on the PC that has the fax modem or modems that you want network users to be able to access. The installation leads you step by step through the process. Other than giving your workgroup a unique name, selecting and setting up your fax modem, and selecting the maximum number of users that can access it, you have few major decisions to make.

WinFax Pro has always been versatile at setting up modems, and the network version is no exception. Setup automatically detects whether you have a Class 1, Class 2, or CAS (the Intel-specific Communications Applications Specification) fax modem installed and pops up a menu of specific related modems. The initial release of WinFax Pro for Networks has over 300 fax modems in its menu. If your modem isn't among them, you can haul out your fax modem's manual and set things up manually. (You can specify whether a particular modem is send-only, receive-only, or send-and-receive, or even if it's private to the server.) There are other (optional) settings as well. If you have multiple fax modems, you can separate them into groups and specify which should be used first if all are available. This option comes in handy if one of your modems is connected to a long-distance line with the lowest rates.

Cramming RAM

There is one "gotcha" to the WinFax Pro for Networks server software: It requires a DOS TSR program that takes about 90 KB of RAM. Luckily, setup gives you the option of running the server TSR in UMBs (upper memory blocks) or in extended memory. If you're running a loaded system, this could require some tweaking, especially if you're using a memory manager like 386Max or QEMM. On my server, all the UMBs were already in use, and my copy of 386Max wasn't set up to supply extended memory. Furthermore, I didn't have enough room to run the server in low memory. Reconfiguring 386Max to supply extended memory solved the problem nicely.

continued

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Panasonic MPC CDR Int	217
Pinnacle RW 125MB 3.5	1690
Pinnacle RW 650MB 5.25	2915
Texel CDR DM3025 SCSI	358
Tosh 3401 SCSI Int/Ext	475/585

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Reviews WinFax Pro Hits the Network

One unusual aspect of the server installation is that you don't set up user accounts—except for a client account on the server if you also want to use the server PC for directly sending faxes. This saves lots of time, but the product's unique approach to network security will make some control-oriented system administrators a bit nervous, especially in large installations. Users set up accounts as they install the client software on their workstations. That's not as strange as it seems at first, because each client must have a unique serial number. That means, for example, that someone couldn't make a copy of the client software and run it from another machine on the network. The server would reject the duplicate serial number.

About the Product

WinFax Pro for Networks

Basic package (one server and two clients)	$399
Additional server	$179
10-user package	$999
25-user package	$2249
50-user package	$4299
Free network upgrade for existing WinFax Pro 3.0 users	

Delrina Corp.
6830 Via Del Oro, Suite 240
San Jose, CA 95119
(800) 268-6082
(408) 363-2345
fax: (408) 363-2340
Circle 1075 on Inquiry Card.

Serving the Client

Setting up the client side of WinFax Pro for Networks is almost identical to installing WinFax Pro 3.0 for Windows. The setup detects that the network server version has already been installed, so there's no need to choose a modem. The only additional network-specific chore is to specify your network E-mail system if you're using one. WinFax Pro for Networks supports all VIM (e.g., Lotus cc:Mail), MAPI (e.g., Microsoft Mail), and Novell MHS–based E-mail systems.

Finishing up the client installation requires a few additional choices, such as choosing a default cover page, filling in default fax-header information, and deciding whether you want to automatically enable the OCR (optical character recognition) that's built into the package. Delrina's OCR, based on Caere's AnyFax technology, is accurate and fast. Of course, whether you'll want to use OCR depends largely on the type of fax traffic you receive. I usually receive short faxes that I read and discard. But if you need to store or edit faxes, OCR's ability to turn graphical fax images into editable text can be handy.

After installation, you can create and send faxes just as with the stand-alone package. You can fax directly from Windows applications by using the WinFax printer driver, which is automatically installed during setup. If you have more than one fax modem on your network, there's only one additional step when you send a fax. You can choose to use the first available modem, a specific modem, or the first-available modem in a group (if the servers have been set up that way).

Saving Server Cycles

When you tell WinFax Pro for Networks to send a fax, the package checks for a free modem (or for whether a specified modem is free). If a modem is free, the fax gets routed to the server and immediately sent. But what happens if it can't immediately send the fax is unusual. Unlike with competing packages, the pending outgoing fax isn't stored in the server until the fax modem becomes free. Instead, it's stored locally on the workstation. This has both advantages and disadvantages.

One advantage is security. Since the fax isn't stored on the server, it can't be accessed by someone who has access to that machine. Another advantage is that the server doesn't need to have large amounts of free hard disk space for storing outgoing faxes.

On the minus side, network traffic increases, because the client continually polls the server until the fax modem frees up. This isn't a problem for small or lightly used networks, but it can create performance problems on large, heavily used networks with lots of fax traffic; the network can get bogged down with lots of packets looking for a free fax modem. Delrina says this situation will be handled soon with an optional WinFax Pro for Networks module that will implement true server-based fax queuing. It should be available by the time you read this, but pricing wasn't available at press time.

The Incoming-Fax Shuffle

Faxing gets a lot more complicated when it comes to handling incoming transmissions—because of a limitation of fax technology, not the product. Unfortunately, the easiest way to route incoming faxes to their intended recipients is to install the WinFax Pro for Networks server on a PC used by someone whose designated responsibility is to handle incoming faxes—what the setup calls the "fax receptionist," who views faxes and sends them to the correct recipient.

The easiest way to do this is via E-mail. But if your network does not have E-mail, WinFax Pro for Networks can send faxes within the network: The fax receptionist refaxes the incoming fax to the recipient. This sounds strange, but it works well. Of course, the major problem with all these manual methods is that incoming faxes are far from secure. Anyone can read them. But that's true with a standard fax machine, too.

There are ways to automatically route incoming faxes directly to the correct recipient on the network, but the process isn't simple, at least at the present time. It also requires special hardware. DTMF and DID (direct inward dial) direct incoming-fax routing requires Intel Satisfaxtion modems on the WinFax Pro for Networks server and sending fax machines that support direct routing. (At present, few do.) The fax sender has to enter an extension number and then send the fax, which gets directly routed to the correct recipient.

There is hope for a simpler way in the future. The CCITT, which sets international telecommunications standards, is working on an automatic fax-routing protocol that would work with an expanded version of the telephone company's Caller ID. Delrina says WinFax Pro for Networks will support that service when it becomes available. But realistically, for most users of WinFax Pro for Networks, manual routing of incoming faxes is what you'll need to use, inconvenient or not.

The WinFax Future

By the time you read this, client support should be available for both WinFax Pro for DOS and WinFax Pro for Macintosh, as well as the above-mentioned server fax queuing. Further out, the company plans modules that offer enhanced system administration and security, as well as a module for modem pooling, sharing modems used for data communications.

The easy installation and scalability of WinFax Pro for Networks make it a logical choice for a variety of networks. Its ability to grow with and adapt to changing company needs is unique. It won't meet the needs of everyone, especially large corporate network installations with special needs (e.g., a customer-support department). But for many users, WinFax Pro for Networks is an elegant solution to the thorny problem of LAN-based faxing. ■

Stan Miastkowski is a BYTE consulting editor. He has wide experience in connectivity and communications and is the coauthor of the Windows for Workgroups Bible *(Addison-Wesley, 1993). You can reach him on the Internet or BIX at stanm@bix.com, or via MCI Mail at 530-9979.*

VocalChat
the first voice communication tool on your LAN

Make sure your own voice is heard across the LAN

VocalChat is a unique Windows product that brings real-time voice communications to local area networks. It enhances office productivity by adding intra-office and digital voice mail features to any audio equipped PC.

VocalChat enables everyone on the network to talk to one another, broadcast announcements, or leave voice messages.

"It supports anybody's voice board, and the price is very low... The capabilities make it ideal for workgroups and quick conferencing."
PC Week

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DEALERS INQUIRIES WELCOME

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76 CARDS FOR FAST GRAPHICS

Our custom tests use real-world applications to find the fastest accelerator cards for Windows and the Macintosh

JIM HURD AND MARK PAXSON

Users have always wanted faster graphics and truer colors, but until today's sophisticated chip technologies and new bus architectures appeared, these goals were attainable only at high costs. But for this report, we tested 76 color graphics accelerators for Windows and the Macintosh and found dozens of fast cards that are also economical, whether your work centers on mainstream Windows tasks or high-end Macintosh graphics applications.

Our test sampling included both DRAM- and VRAM-based (video RAM) accelerators, in configurations that ranged from 1 MB of video memory to 4 MB or more. However, to be considered for this roundup, a board had to run at a minimum of 1024- by 768-pixel resolution with 256 colors in noninterlaced mode. Our rankings also include boards that run at 1024 by 768 resolution with 64,000 and 16.7 million colors, as well as at 1280 by 1024 resolution with 256 colors. We tested boards only in their noninterlaced modes.

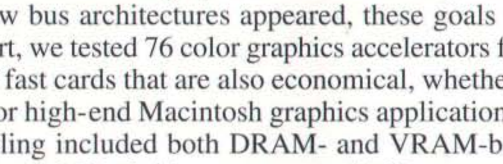
If you just need the power of a 1-MB video board to run general-business applications, a DRAM-based adapter fits the bill for a low cost. We tested 10 such boards that retail for less than $200. If you need higher resolutions and more colors, you'll need a more expensive VRAM-based board to achieve good picture quality. While the fastest boards we tested all use VRAM, our tests show that the performance difference is

How to use this guide

To find the best graphics accelerator board for your needs, follow the main headings until you come to the appropriate bus architecture and then look for the subcategory that is most relevant to your work.

PC-based accelerators are grouped by the resolutions and color levels they support rather than traditional Lab Report rankings based on best overall and low cost (our Mac rankings follow the traditional breakdowns).

The time (in seconds) it took the graphics adapter and driver to draw a screen image. The tests use a collection of screens from top Windows and Macintosh applications. Lower numbers indicate faster performance.



Need speed for general business?

GENERAL PURPOSE **Hercules Dynamite VL Pro D602**

All the adapters based on the Tseng Labs ET4000/W32 chip offered uniformly excellent performance and under-$350 prices. But we give the nod to the Hercules Dynamite VL Pro for its superior documentation, configuration software, and support. The 0.7-second average screen draw for the W32-based boards puts them among the fastest boards for 256-color, 1024- by 768-pixel display resolution, despite their frugal DRAM-based design.

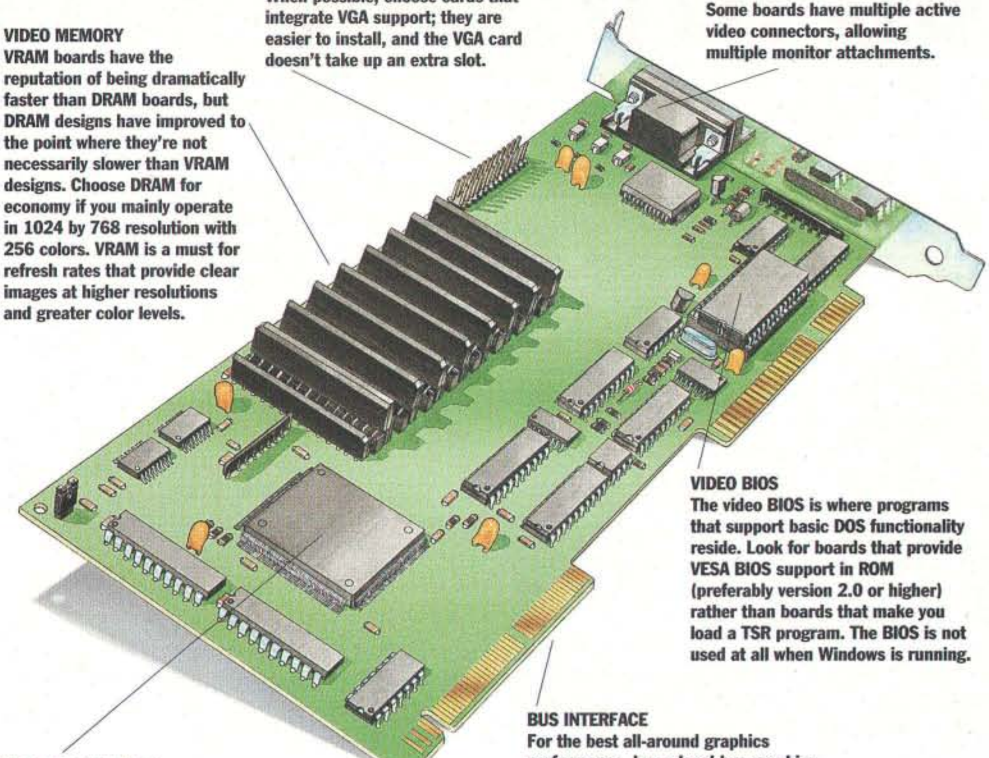
		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS AUTOCAD	OS/2	WINDOWS 3.1	UNIX
BEST	Hercules Dynamite VL Pro D602	0.697	▲▲▲	$299	2 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Sigma Designs Concorde VLB	0.700	▲▲▲	$349	1 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Focus Truespeed/W32	0.696	▲▲▲	$169	1 MB	Tseng Labs ET4000/W32	✓	✓	✓	
RUNNER-UP	Diamond Viper VLB	0.667	▲▲▲▲	$499	2 MB	Weitek Power 9000	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite VL Pro HG720	0.683	▲▲▲	$549	2 MB	IIT AGX015	✓	✓	✓	

Price as configured; typically, the cost varies based on the amount, kind, and speed of RAM installed.

▲▲▲▲ (Excellent) boards came with installation software and the clearest manuals; ▲▲▲ (good) identifies boards that can be installed without checking the documentation; ▲▲ (fair) boards required a check of the user's manual; ▲ (poor) boards needed jumper resettings.

PHOTOGRAPHY: STEVE BELKOWITZ © 1994

Accelerator Essentials



VIDEO MEMORY
VRAM boards have the reputation of being dramatically faster than DRAM boards, but DRAM designs have improved to the point where they're not necessarily slower than VRAM designs. Choose DRAM for economy if you mainly operate in 1024 by 768 resolution with 256 colors. VRAM is a must for refresh rates that provide clear images at higher resolutions and greater color levels.

PASS-THROUGH CONNECTOR
Commonly called a feature connector, this is required for boards that must use a separate VGA card. When possible, choose cards that integrate VGA support; they are easier to install, and the VGA card doesn't take up an extra slot.

MONITOR INTERFACE
Most video cards provide a single video connection based on the standard D-shell, 15-pin VGA connector. Some high-end boards offer RGB connectors (i.e., BNC). Some boards have multiple active video connectors, allowing multiple monitor attachments.

VIDEO BIOS
The video BIOS is where programs that support basic DOS functionality reside. Look for boards that provide VESA BIOS support in ROM (preferably version 2.0 or higher) rather than boards that make you load a TSR program. The BIOS is not used at all when Windows is running.

BUS INTERFACE
For the best all-around graphics performance, buy a local-bus graphics card if your computer supports either a PCI (Peripheral Component Interconnect) or the VL-Bus. These interfaces give you the highest bandwidth connection to your video card. The difference is especially noticeable in raw pixel copies.

VIDEO ACCELERATOR
Most accelerators combine VGA compatibility into the accelerator chip to save cost. The fastest boards in our tests used accelerators from Tseng Labs, Weitek, or IIT, or a proprietary design. The lowest-cost accelerator designs pack the DAC (D/A converter) onto the accelerator chip, but most video boards still have a separate chip responsible for turning the digital information stored on the card into an analog signal to drive the monitor.

usually minuscule; often a fast DRAM adapter will outperform an average VRAM board.

To gauge performance for real-world conditions, we used 15 test screens that included such commercial graphics-intensive applications as CorelDraw, Microsoft Excel, and Aldus Persuasion. We based our tests on actual applications because many video adapters continue to be tuned more for benchmarks rather than for real-world use.

We tested adapters for four different bus interfaces: VL-Bus, ISA, EISA, and NuBus. Some drawing operations do not stress the bus speed enough to show any significant performance advantages of using the faster VL-Bus. But copying images from memory to screen (known as *Blting*), which is especially important for graphics illustration and multimedia applications, was the major exception: VL-Bus adapters generally outperformed their ISA and EISA counterparts by a margin of more than 2 to 1 in this operation.

Our test sample also included a wide variety of graphics accelerator chip sets. The most inexpensive boards were based on the Cirrus Logic GD5426 accelerator. The fastest chip sets varied by application and vendor implementation, but boards powered by the Tseng Labs ET4000/W32; the Weitek Power 9000; the IIT AGX015; and proprietary accelerators by Compaq, SuperMac, Appian, and Matrox ran fastest. Our rankings don't include boards that use the Texas Instruments 340x0 coprocessor. Although it is flexible, the 340x0 architecture is being overtaken by the lower-cost, higher-performance boards with fixed-function graphics accelerator chips.

FEBRUARY 1994 BYTE BEST GRAPHICS CARD **BEST**

VL-BUS GENERAL-PURPOSE

Hercules Dynamite VL Pro D602

The $299 Dynamite VL Pro D602 offers performance and price that are similar to those of the handful of other DRAM-based boards that use Tseng Labs' W32 chip set. The Dynamite VL Pro D602 gets the winning nod thanks to its superior documentation, configuration software, and technical support.
PAGE 149

ISA BUS GENERAL-PURPOSE

Paradise/Western Digital Accelerator 24

This $199 board's installation is somewhat cumbersome because of jumpers that may need to be reset, but once you get over this small hurdle, the Accelerator 24 offers excellent performance, solid support, and the best value for those who use ISA systems for general-business applications.
PAGE 155

MACINTOSH NUBUS

Radius PrecisionColor Pro

In overall speed, this was the fastest of the 10 24-bit NuBus boards we tested. The PrecisionColor Pro also offers the added advantage of letting you change resolutions without rebooting your Macintosh.
PAGE 161

EISA BUS GENERAL-PURPOSE

Compaq QVision 1280/E

Ranked best for general-purpose applications, this board also excelled for use with CAD applications. Its speed for 256-color graphics modes runs as fast as many VL-Bus boards, thanks to Compaq's well-tuned drivers. The board's text and complex-graphics speeds rank with those of the fastest boards designed for use with any type of bus.
PAGE 165

ILLUSTRATION: BRUCE SANDERS © 1994

THE BEST GRAPHICS ACCELERATORS FOR VL-BUS SYSTEMS

We saw the biggest speed gains from VL-Bus in the true-color cards designed for graphics illustration and desktop publishing. For example, SuperMac Technology's Spectrum/24 for VL-Bus was over 30 percent faster than its Spectrum/24 for ISA.

To rank cards for the general-purpose category, we compared test results for all cards that ran in 1024 by 768 resolution with 256 colors. Although the Diamond Viper VLB was the fastest adapter when using 256 colors, it was less than 5 percent faster than the top three general-purpose adapters, which cost less than the Viper VLB.

All of the top three boards used the Tseng Labs ET4000/W32 accelerator chip, whose speed and price make it the best value for this mainstream market. By using four-way memory interleaving, Tseng Labs' chip wrings out remarkable performance from low-cost DRAM. The W32-based adapters were only hundredths of a second slower than the Diamond Viper VLB and faster than many VRAM designs. By virtue of its compatibility with Tseng's popular ET4000 chip, the ET4000/W32 comes out of the box with reliable drivers for all popular operating systems.

Our favorite W32-based adapter is the Hercules Dynamite VL Pro D602. However, because W32-based cards are so similar, we recommend that you shop around and compare the Dynamite VL Pro to its W32-based cousins to get the best price (but don't forget to factor in support).

Interlaced displays are a bad buy at any price because of their high levels of flicker. Either pocket the $50–$60 it will cost you for an extra megabyte of memory or put the money toward an adapter that can take advantage of the extra memory.

Our direct-color rankings considered boards capable of 1024- by 768-pixel resolution with 64,000 colors, which excluded boards with less than 2 MB of memory.

Boards like the $490 Appian Technology Renegade 1280 VL Pro and the ATI Graphics Ultra Pro VLB make 16-bit color increasingly affordable and attractive.

The ATI Graphics Ultra Pro was the only adapter we received with a shipping direct-color driver for Windows NT.

Our desktop publishing rankings considered boards capable of providing 16.7 million colors at 1024- by 768-pixel resolution. Well-established in the Macintosh world, SuperMac Technology is acting like anything but a newcomer with the Spectrum/24 VL for Windows.

The board was a shade slower

Promising Beta

Although it wasn't yet in production during our testing, we found the beta version of the Actix Systems Graphics Engine 32 VL plus particularly interesting. The board is based on a prototype S3 86C805I accelerator chip, which adds memory-interleaving support to the widely used 86C805 chip. The Actix 32 VL plus board is notable as perhaps the first DRAM design that offers noninterlaced 1280 by 1024 resolution with 8-bit color and 1024 by 768 resolution with 16-bit color.

Also of note are the beta S3 drivers that come with the 32 VL plus. Even on the current-generation 86C805-based boards, such as the Nth Graphics Nth S3 Advantage/VL and the Volante Warp10LB, these new drivers offer a 25 percent speed improvement, which is enough to put those boards at the top of the performance pack.

PCI: STILL JUST A PROMISE

At the time of testing, we could obtain only three PCI-based (Peripheral Component Interconnect) video adapters; all were preproduction models. Our test-bed system, however, was a production model of IBM's PS/ValuePoint P60/D. Aside from its being available, the other interesting aspect of this system was its built-in video, from ATI Technologies. We used this feature to examine the self-configurability of the PCI adapters.

Of these three adapters, only Diamond's Viper PCI worked flawlessly. The other two PCI cards, the Graphics Ultra Pro PCI from ATI Technologies and the IGP64 PCI from Infotronic America, had compatibility problems.

PCI SYSTEM	RESPONSE TIME (SECONDS)		
	1024 by 768; 256 colors	1024 by 768; 64,000 colors	1280 by 1024; 256 colors
Diamond Viper PCI	.586	.607	.626
Infotronic IGP64 PCI	N/A	N/A	.843
IBM ValuePoint system, with built-in ATI PCI	.788	N/A	N/A

N/A = not available.

The ATI Graphics Ultra Pro PCI failed to run in the IBM system; however, it did run in a preproduction system from Gateway. IBM and ATI theorized that the PCI BIOS resource manager had a problem with the concurrency of the two ATI video controllers. Infotronic's IGP64 board and driver still needed a lot of development and cleanup work.

The problems that we encountered demonstrate that PCI technology is not quite ready for the mass market.

than the fastest board in this category, the Matrox MGA Impression/3/V, but lower cost and higher resolution tip the scales in the Spectrum/24's favor: The board retails for $300 less than the Impression/3/V. What's more, the Spectrum/24 supports 16.7 million colors at 1152 by 910 resolution, versus 16.7 million colors at 1024 by 768 resolution for the Impression/3/V. Those extra pixels can mean the difference between a full page and an "almost-full" page in your favorite desktop publishing package. One serious flaw with the Spectrum/24, however, is its requirement of a separate VGA adapter connected via the pass-through connector.

We are tempted by the Pro Graphics 1280's greater value, but it seems Media Vision needs more time to tweak its drivers.

For CAD/CAM evaluations, we considered cards capable of 1280- by 1024-pixel resolution with 256 colors. For people who make their living using CAD, we recommend the Matrox MGA Impression/3/V. The board is clearly geared for CAD: It comes with a separate manual just for Matrox's AutoCAD support software.

If you work with Windows-based CAD packages, you'll benefit from the MGA Impression/3/V's unique mode-switching. The board can fool Windows into treating it like a 24-bit board even when you're operating in 8-bit mode.

With this feature you can define a monstrous 1600- by 1200-pixel virtual desktop with hardware panning in which to do your design work. At any time you can see the rendered result in true 24-bit color by simply pressing a key.

The lower-priced alternatives in this category support a form of hardware-assisted panning and provide AutoCAD-specific drivers and documentation.

KEY

Ease of Use:

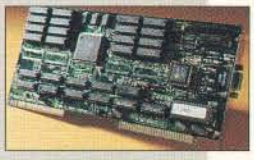
Excellent ▲▲▲▲	Fair ▲▲
Good ▲▲▲	Poor ▲

BYTE BEST | VL-BUS GRAPHICS ACCELERATORS

Need speed for general business?

GENERAL PURPOSE

Hercules Dynamite VL Pro D602



FEBRUARY 1994
BYTE
BEST
GENERAL-PURPOSE
GRAPHICS CARD (VL)

All the adapters based on the Tseng Labs ET4000/W32 chip offered uniformly excellent performance and under-$350 prices. But we give the nod to the Hercules Dynamite VL Pro for its superior documentation, configuration software, and support. The 0.7-second average screen draw for the W32-based boards puts them among the fastest boards for 256-color, 1024- by 768-pixel display resolution, despite their frugal DRAM-based design.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Hercules Dynamite VL Pro D602	0.697	▲▲▲	$299	2 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Sigma Designs Concorde VLB	0.700	▲▲▲	$349	1 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Focus Truespeed/W32	0.698	▲▲▲	$169	1 MB	Tseng Labs ET4000/W32	✓	✓	✓	
RUNNER-UP	Diamond Viper VLB	0.667	▲▲▲▲	$499	2 MB	Weitek Power 9000	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite VL Pro HG720	0.683	▲▲▲	$549	2 MB	IIT AGX015	✓	✓	✓	

Do you need 64,000 colors?

DIRECT COLOR

Appian Renegade 1280 VL Pro

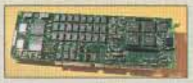
For displaying 1024 by 768 resolution with 64,000 colors, nothing could touch the speed and price of the Renegade 1280 VL Pro. The board was one of the few we tested that ran faster in 64,000 colors than in 256 colors (0.65 second versus 0.71 second).

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Appian Renegade 1280 VL Pro	0.650	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	Matrox MGA Impression/3/V	0.701	▲▲▲	$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro VLB	0.780	▲▲▲	$499	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP	Diamond Viper VLB	0.880	▲▲▲▲	$499	2 MB	Weitek Power 9000	✓	✓	✓	✓

When true color is mandatory...

DESKTOP PUBLISHING

SuperMac Spectrum/24 VL



Offering 16.7 million colors at a maximum resolution of 1152 by 910 pixels, the Spectrum/24's 0.8-second average screen draw was second only to that of the more expensive and lower-resolution Matrox MGA Impression/3/V. The Spectrum/24's documentation and driver reliability are impeccable. Unfortunately, it requires a separate VGA adapter.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	SuperMac Spectrum/24 VL	0.798	▲▲	$999	3 MB	Proprietary			✓	
RUNNER-UP	Media Vision Pro Graphics 1280	0.839	▲▲▲	$995	4 MB	Media Vision MVV451	✓	✓	✓	
RUNNER-UP	Matrox MGA Impression/3/V	0.779	▲▲▲	$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	STB Systems Pegasus VL	1.015	▲▲▲	$849	4 MB	S3 86C928	✓	✓	✓	

For high resolution and fast performance...

CAD/CAM

Matrox MGA Impression/3/V

This board combines fast performance with a unique mode-switching capability that lets you go from 256 colors to 16.7 million colors and back with a single keystroke.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Matrox MGA Impression/3/V	0.795	▲▲▲	$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	Appian Renegade 1280 VL Pro	0.821	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite VL Pro HG720	0.852	▲▲▲	$549	2 MB	IIT AGX015	✓		✓	
RUNNER-UP	Diamond Viper VLB	0.827	▲▲▲▲	$499	2 MB	Weitek Power 9000	✓	✓	✓	✓

*SCO Open Systems' version of the X Window System.

How We Tested

For most applications, the video adapter is the biggest bottleneck in system performance. For example, a modern hard disk can load a 3-D bar chart in 40 milliseconds, while a fast video adapter needs about 700 ms to display the same image.

To create a comprehensive series of tests to identify the graphics accelerators that can shorten the performance bottleneck, we first sought to identify the most important markets for video adapters. We concentrated on four PC applications and the high end of Macintosh graphics, as outlined below.

General-purpose. 1024 by 768 resolution with 256 colors; for general-business applications and mainstream Windows users.

Direct color. 1024 by 768 resolution with 64,000 colors; for high-end Windows graphics applications, graphic designers, and multimedia producers.

Desktop publishing. 1024 by 768 resolution with 16.7 million colors; for desktop publishers and graphics illustrators creating color publications.

CAD/CAM. 1280 by 1024 resolution with 256 colors; for engineers, architects, and draftspersons.

Macintosh graphics. 1152 by 870 resolution with 16.7 million colors; for desktop publishers and graphics illustration.

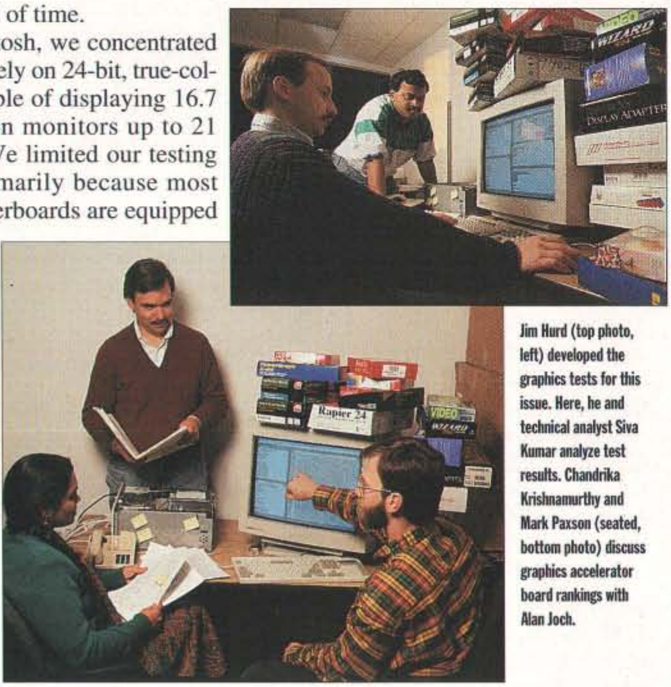
We required test boards for the PC platform to support a minimum of 1024 by 768 pixels with 256 colors in noninterlaced mode. Boards had to have a minimum of 1 MB of memory, but if an adapter could support higher amounts of RAM, we asked vendors to supply the greater amount, up to 4 MB.

Beyond the scope of this roundup are video adapters with coprocessors, such as the Texas Instruments 34020 chip. We tested a board in each resolution and at a color level that the board supported in noninterlaced mode. Because of screen flicker, we don't recommend using any board in interlaced mode for a prolonged period of time.

Comparing Scores

When comparing performance scores among various boards, consider differences of less than 5 percent to be unnoticeable in actual use. You're likely to spot the difference in a board that ran 10 percent faster than a competitor, but the difference may not be enough to affect your productivity. A 25 percent speed difference is great enough to choose a board for the productivity gains it offers compared to a slower alternative.

On the Macintosh, we concentrated our tests exclusively on 24-bit, true-color adapters capable of displaying 16.7 million colors on monitors up to 21 inches in size. We limited our testing to this class primarily because most Macintosh motherboards are equipped with excellent video capabilities for less-demanding applications.



Jim Hurd (top photo, left) developed the graphics tests for this issue. Here, he and technical analyst Siva Kumar analyze test results. Chandrika Krishnamurthy and Mark Paxson (seated, bottom photo) discuss graphics accelerator board rankings with Alan Joch.

Performance was our primary criterion for selecting winners. After we chose the top performers in each category, we ranked the winners and the runners-up by considering the cost, support options, usability, and any unique features the boards offered. Because of differences in retail and street prices, we considered a 15 percent cost difference to be insignificant.

In ease-of-use scores, adapters received a rating of "good" if an average user could install them without referring to the manual. An "excellent" ranking was reserved for those adapters that had exceptionally clear and complete documentation and installation software. Boards that were rated "fair" required you to consult the documentation, while boards receiving a rating of "poor" needed a variety of jumper changes and/or a call to the company's technical support to configure them correctly.

Although usability included how easy a card was to install, this judgment was tempered somewhat by the fact that installation is typically a one-time task. Once you get even the most troublesome board up and running, you're likely to be concerned only about performance for the rest of that board's life.

We also considered any unique utilities or hardware features that gave a board an advantage in any of our application rankings. For example, the Matrox MGA Impression/3/V offers mode switching, which lets CAD designers display 24-bit output with 8 bits per pixel and then switch dynamically to true 24-bit color for 3-D rendering. This feature and the board's CAD-specific documentation helped the Impression/3/V rise to the top in our VL-Bus CAD/CAM evaluations. Finally, we did not consider adapters for honors unless they could complete the entire test without compatibility problems, and they had to produce a clear, stable picture.

We also gave higher marks to boards that didn't require a separate VGA adapter, which not only slows the installation process but takes up an additional slot in your system. Finally, boards received higher marks if you could reach the company's support staff through a variety of methods, including a company BBS, a toll-free phone number, and a fax number.

PERFORMANCE

When writing our performance tests, we placed the most emphasis on pro-

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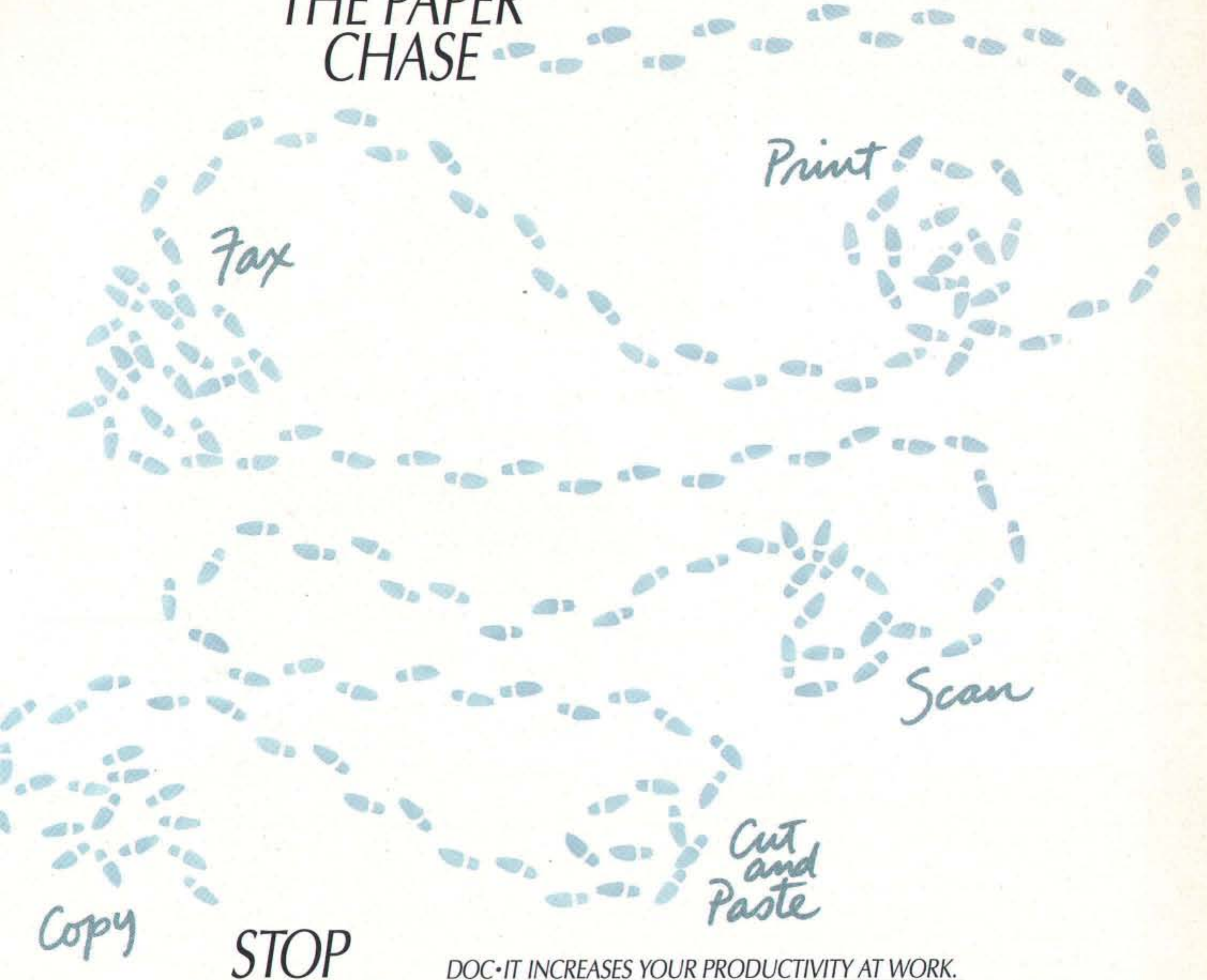

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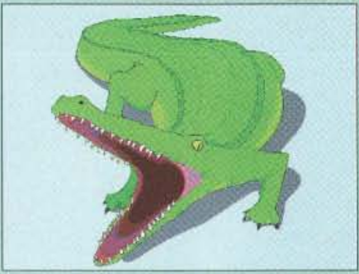
How We Tested *(continued)*

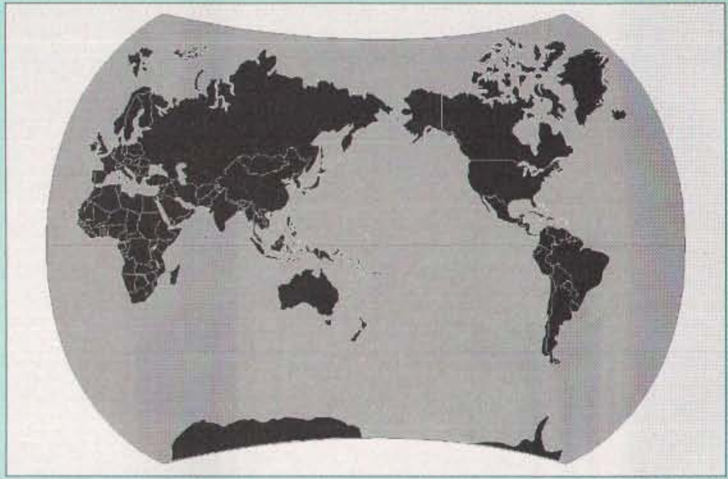
ducing tests that were a meaningful reflection of real-world conditions. To reproduce the performance of graphics applications, we designed our tests using images produced from CorelDraw, Corel Presents, Microsoft Excel, and Microsoft Word for Windows. In all, we required each board to display 15 test screens, ranging from straight text, to 2-D and 3-D bar charts, to complex full-color drawings. See the box at right for test samples.

Test Samples

This Microsoft Excel bar chart helped represent business graphics.



A CorelDraw image helped gauge color graphics speed.



This world map tested speeds for complex monochrome drawings.

We had hoped to use CorelDraw and Corel Presents as cross-platform applications for both our Windows and Macintosh tests, but delays in QuickDraw GX sidelined CorelDraw for Macintosh. Instead we used Corel's export filters to convert our drawings into PICT format. We also incorporated images from the Macintosh versions of Microsoft Word, Microsoft Excel, and Aldus Persuasion. (Because the pictures we used were specific to the platform, you should avoid making generalizations about Mac performance versus PC performance on the basis of these test results.)

In addition to mirroring real-world demands, we also designed our tests to be "cheat proof." Some graphics benchmarks, for example, use profiling to define real-world usage; however, the tests consist simply of lines being drawn on top of each other. A clever writer of video drivers can improve speeds in such tests by adjusting the driver to draw the first line and ignore the rest.

To avoid this problem, we used full application screens exactly as they are produced by applications. To further increase our test accuracy, we used microsecond resolution timing. This allowed us to accurately measure a single screen paint, and it avoids the problem of drawing the same screen repeatedly (which is unrealistic and easy to "optimize away" in the driver).

Our Windows test software draws each of the 15 application screens into both system memory and video memory using four different color modes for more than 120 tests in all. We also measured the time it took to refresh the screen from an image cached in memory at screen depths of 1, 2, 4, 8, 16, and 32 bits per pixel. (Well-written applications will cache display images in system memory whenever possible to improve response times.)

To reach an overall response time, we averaged test results using weights derived from profiling typical Windows usage. The overall response time is the average time needed to repaint the entire screen. Use this number to gauge the performance of boards that support resolutions and color levels appropriate to your applications.

Our Macintosh tests performed similarly, except that we tested only in 24-bit-color mode, and drawing in memory was not a consideration because this relies only on the Macintosh Toolbox code and not on the video adapter.

TEST-BED

We tested the ISA and EISA boards in a 66-MHz 486DX2 Compaq Deskpro 66M with 8 MB of memory. For the VL-Bus boards, we used DEC's MTE 486/66 with 16 MB of memory. Technicians conducted all tests using Microsoft Windows 3.1. Macintosh testing was done on a Mac Quadra 840AV with 16 MB of RAM.

Contributors

Jim Hurd, *Vice President of Research and Development/NSTL, wrote the graphics benchmarks for this report. He has developed numerous tests for hardware and software during the last 10 years.*

Helen Holzbaur, *Project Manager/NSTL, was a network manager and systems administrator at Temple University for 10 years before joining NSTL.*

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

Chandrika Krishnamurthy, *Technical Analyst/NSTL, evaluates peripherals and systems.*

Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network operating-systems testing.*

Mark Paxson, *Manager of Design-Verification Testing Services/NSTL, specializes in hardware compatibility testing.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.

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THE BEST GRAPHICS ACCELERATORS FOR ISA-BUS SYSTEMS

While VL-Bus video receives most of the attention, ISA video adapters are offering more capabilities than ever at bargain-basement prices of as low as $149. Even more surprising is the fact that the ISA cards that we tested typically performed just 5 percent to 15 percent slower overall than comparable VL-Bus cards.

Why isn't ISA slower? After all, ISA offers a modest bandwith of 8 MBps maximum, compared to VL-Bus's maximum of 132 MBps. However, for most graphics operations, VL-Bus adapters don't move data at speeds anywhere near the bandwidth of the bus.

The VL-Bus advantage is most evident in *Blting*, which is a straight pixel copy from memory to the screen. (*Blt* is an abbreviation for "block transfer.") For example, a fast ISA card on a straight pixel copy will attain just under 7 MBps, while a fast VL-Bus adapter will top 16 MBps. This corresponds to a complete screen repaint (using 1024 by 768 pixels by 256 colors) of under .05 second for VL-Bus versus .11 second for ISA.

The Achilles' heel of ISA video cards is the limited address range of the ISA bus. Many of the fastest cards, such as Compaq's QVision 1280/I, gain their speed by mapping VRAM into high memory. The QVision drivers that we tested would work only in this "flat-mapped" memory configuration. The ATI Graphics Ultra Pro ISA will work with or without flat-mapping, but flat-mapping offers a substantial performance boost. The problem with flat-mapping in an ISA system is that you are generally limited to 12 MB of system RAM, an amount that seems smaller every day.

The Paradise/Western Digital Accelerator 24 offers the best

When Video Drivers Matter

Under Windows (but not the Mac), video-driver software is vital for drawing images in system memory. Typically, video acceleration hardware cannot be used for this task, so the performance rests solely on the cleverness of the driver software.

The speed of drawing images in system memory is crucial to overall system response time, because many applications will prepare the image in memory and then copy the finished image to the screen.

Even on fast 486/66 machines, the performance of the software driver is often more important than the speed of the video hardware. We found instances where a new driver would boost a board's performance by 25 percent, enough to move it from the bottom of the heap to near the top. If you haven't upgraded your driver recently, it might pay to check out your vendor's BBS for any recent enhancements.

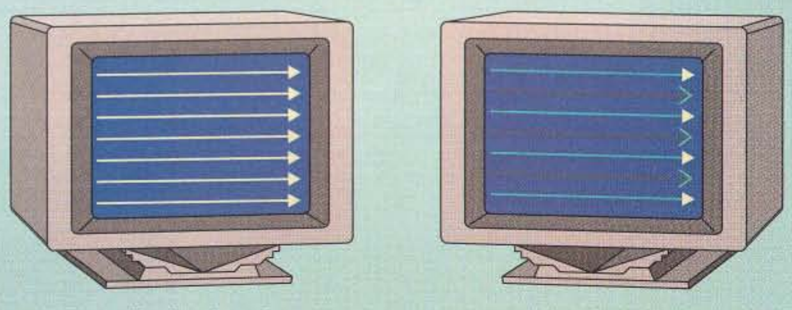
The difference in driver performance is even more dramatic when using operating systems other than Windows. Our top-performing board for use with Windows NT was the Hercules Dynamite VL Pro D602, a low-cost DRAM board; its faster driver far outweighed its marginally slower hardware.

AVOID INTERLACING

In deciding what graphics accelerator to buy, make sure you weed out those that support only resolutions that are used in interlaced mode, because eyestrain will result if you work for long periods of time with an interlaced display. Nevertheless, vendors continue to provide interlaced modes, even though monitors designed with the slow phosphor needed for interlacing are rare. Worse, many vendors don't make it clear what resolutions require interlacing. We strongly suggest that you ignore interlaced modes when making your purchase decision.

Also, be wary of advertised resolutions that require 90-Hz refresh rates. Usually, this indicates that interlacing has been implemented by the vendor: The actual refresh rate is 45 Hz, which is doubled to cover the two refresh sweeps.

At the time of our testing, all the DRAM-based boards implemented interlacing in modes that required 2 MB of memory. For this reason, we recommend that you purchase DRAM-based boards with only 1 MB of memory if they only run interlaced modes with 2 MB.



Noninterlaced

Interlaced

value for general-purpose applications (1024 by 768 pixels with 256 colors). Despite its price/performance strengths, the Accelerator 24 offers only fair usability: It was among a handful of boards we tested that may require you to change jumpers, depending on your system configuration.

The S3 86C801–based STB PowerGraph X-24 also lists for $199 and, also like the Accelerator 24, it is DRAM-based. The PowerGraph was the slowest of the boards ranked for this category, but new S3 drivers, which were in beta at the time of our testing, showed a noticeable improvement over the released drivers we used for our formal rankings.

The lowest-cost boards we tested were based on the Cirrus Logic GD5426 chip. These boards include the STB Horizon VGA ($159) and Cardinal's VideoSpectrum XL ($149).

The standard GD5426 drivers are not the easiest to install, however; you must separately install a DOS utility to set the monitor refresh.

You'll need higher-cost VRAM-based boards to produce stable images with 16-bit color at 1024 by 768 pixels. Like its VL-Bus cousin, the 1280 VL Pro, the Appian Renegade 1280 ISA is one of the few adapters that actually ran faster using 16-bit color than it did while using 8-bit color. We didn't like the 1280 ISA's unnecessarily complex installation.

For CAD/CAM applications (1280 by 1024 pixels with 256 colors), our two top choices use S3's 86C928 chip. The Sigma Designs WinMach 1600 was the fastest board in this category by a slim margin, but the Pixelworks WhirlWin-II was $100 cheaper. We gave the nod to the WinMach 1600 for its support of 24-bit color (16.7 million colors) at 800 by 600 resolution.

KEY

Ease of Use:

Excellent ▲▲▲▲	Fair ▲▲
Good ▲▲▲	Poor ▲

BYTE BEST ISA-BUS GRAPHICS ACCELERATORS

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GENERAL-PURPOSE Paradise/W D Accelerator 24

FEBRUARY 1994 BYTE BEST GENERAL-PURPOSE GRAPHICS CARD (ISA)

This board was a top performer among the low-cost DRAM-based adapters. Unlike the top-performing Compaq QVision 1280/I, the Accelerator 24 won't limit your memory expansion. The Accelerator 24 is more difficult to configure than most adapters due to its reliance on jumpers.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Paradise/W D Accelerator 24	0.733	▲	$199	1 MB	WD90C31	✓	✓	✓	
RUNNER-UP	Compaq QVision 1280/I	0.721	▲▲▲	$599	1 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite Pro HG310	0.744	▲▲▲	$399	1 MB	IIT AGX015	✓	✓	✓	
RUNNER-UP	Volante Warp20-2	0.766	▲▲▲	$499	1 MB	IIT AGX-14	✓	✓	✓	
RUNNER-UP	STB Systems PowerGraph X-24	0.865	▲▲▲	$199	1 MB	S3 86C801	✓	✓	✓	

The speed leader in 64,000 colors

DIRECT COLOR Appian Renegade 1280 ISA

Appian Technology builds the Renegade 1280 ISA specifically for direct-color use: It runs faster in 64,000-color mode than in 256-color mode. If you are looking to step up to direct color and want to say good-bye to using palettes, consider the Renegade 1280 ISA.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Appian Renegade 1280 ISA	0.659	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro ISA	0.803	▲▲▲	$499	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP	Compaq QVision 1280/I	0.840	▲▲▲	$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Nth Graphics Nth Edge 1280	0.787	▲▲▲	$995	2 MB	Chips & Technologies 481	✓		✓	
RUNNER-UP	Sigma Designs WinMach 1600	0.832	▲▲▲	$995	2 MB	S3 86C928		✓	✓	

For the best speed in true color...

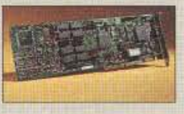
DESKTOP PUBLISHING SuperMac Spectrum/24 ISA

Long a major force in the Macintosh market, the company's offerings dominated our tests for cards capable of 16.7 million colors at 1024- by 768-pixel resolution. However, the board requires a separate VGA graphics adapter.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	SuperMac Spectrum/24 ISA	1.288	▲▲	$999	3 MB	Proprietary			✓	
RUNNER-UP	Raster Ops PaintBoard PC	1.963	▲▲▲	$999	3 MB	S3 86C924	✓		✓	
RUNNER-UP	Number Nine #9GXE	2.700	▲▲▲	$895	4 MB	S3 86C928		✓	✓	

For switching resolutions on the fly...

CAD/CAM Sigma Designs WinMach 1600



The WinMach 1600 supports hardware panning and allows basic image manipulation, such as compression/decompression, antialiasing, rotation, and scaling. The board supports 16.7 million colors at 800 by 600 resolution for photo-realistic rendering and can change resolutions via a hot key.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Sigma Designs WinMach 1600	0.808	▲▲▲	$995	2 MB	S3 86C928		✓	✓	
RUNNER-UP	Pixelworks WhirlWin-II	0.815	▲▲▲	$895	2 MB	S3 86C928	✓	✓	✓	✓
RUNNER-UP	Compaq QVision 1280/I	0.857	▲▲▲	$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Appian Renegade 1280 ISA	0.886	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro ISA	0.967	▲▲▲	$499	2 MB	ATI Mach 32	✓	✓	✓	✓

*SCO Open Systems' version of the X Window System.

Windows NT Drivers: Better Late Than Never?

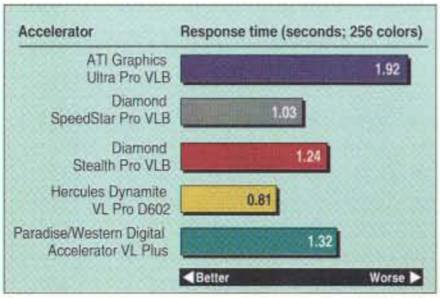
Many of the best-performing accelerators we tested had only beta Windows NT drivers during our test cycle. In fact, the only shipping NT drivers at the time of testing seemed to be those that ship with NT itself. Aside from the drivers with results shown in the accompanying bar chart (all shipped on the Windows NT CD-ROM), we received beta drivers for the SuperMac Spectrum/24 VL for Windows, Diamond Viper VLB, Hercules Graphite VL Pro HG720, and Matrox MGA Impression/3/V.

At this early stage, the low-cost Hercules Dynamite VL pro D602 walks away from the field (but it is still slower than it is in Windows 3.1). The NT tests ran on a 486/66 DEC MTE.

For Windows NT testing, we used software based on the same code as the Windows tests with a few conditional compilation switches. Testing graphics performance under NT can be tricky, thanks to NT's automatic GDI (Graphical Device Interface) instruction batching and dictatorial grasp of memory.

The instruction batching seeks to minimize the overhead of making many small requests to the graphics driver by grouping many small requests into one big request. Carelessly constructed tests can end up measuring the time it takes to place an instruction into this cache, rather than the time it takes to paint the screen.

The memory problem stems from NT's refusal to lock more than 128 KB of a process into memory. This limitation causes problems when testing adapters with 4 MB of VRAM. An unintentional swap can disrupt results.



HOW TO BUY A GRAPHICS ACCELERATOR

Find the Right Color Depth

Although 8-bit boards capable of 256 colors are adequate for Windows and general-purpose applications, consider stepping up to a 16-bit board with 64,000 colors. Ideal for multimedia applications, 16-bit color requires 2 MB of VRAM for 1024 by 768 resolution. For Windows users, the greater color depth avoids the distracting "color flash" that 8-bit boards can produce when you change windows or move among multiple open applications.

Which Bus Is Best?

Overall, little performance difference exists between the fastest ISA, EISA, and VL-Bus graphics accelerators when you run at a relatively small color depth, such as 1024 by 768 pixels with 256 colors. But when you increase the color depth to 24 bits, you will see some significant performance differences between ISA and the other bus types. Therefore, if you're only using 256 colors in your applications and you have an ISA system, the inexpensive ISA-based cards should serve you well.

When Is VL-Bus a Must?

VL-Bus cards can become faster as you add memory to your system. This speed benefit comes because properly designed applications will use available system memory to cache screen information that can then be quickly copied to the screen. This image copying (called Blting) is what really separates VL-Bus cards from other cards: Speedups of over 2 to 1 are common for this operation.

How Much Memory?

Be wary of misleading vendor claims. A board may be advertised as being able to display 16.7 million colors. However, if the board only has 1 MB of video memory, then this color level is possible only at the undesirable resolution of 640 by 480 pixels. If you need lots of color, use the following table as a guide to determine your minimum memory needs.

If you run this resolution	And you use this many colors	Video memory should be at least
640 by 480	16.7 million	1 MB
800 by 600	64,000	1 MB
800 by 600	16.7 million	2 MB
1024 by 768	256	1 MB
1024 by 768	64,000	2 MB
1024 by 768	16.7 million	3 MB
1280 by 1024	256	2 MB
1280 by 1024	64,000	3 MB
1280 by 1024	16.7 million	4 MB

Consider Support

Be sure that your vendor is able to provide you with updated drivers in a convenient manner. Often substantial performance gains will result from the latest, more efficient drivers. On the other hand, high-performance Windows drivers are immensely complex, so there's always a chance that some bug will prevent correct operation, and you should be able to download company fixes quickly.

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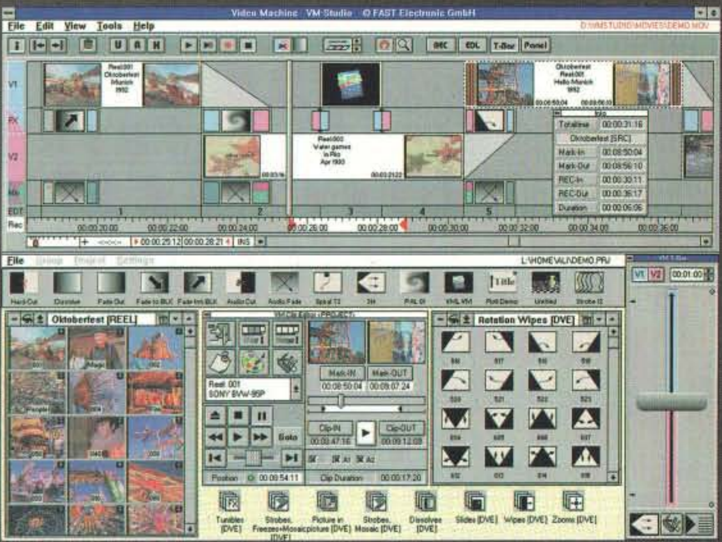
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THE BEST GRAPHICS ACCELERATORS FOR

MACINTOSH NUBUS SYSTEMS

We tested 10 two-page, true-color display adapters for Macintosh-based graphics illustration and desktop publishing. All these NuBus boards were easy to use and produced clear, stable pictures. We used a Mac Quadra 840AV for testing, which is a typical target platform for these cards, because its maximum 2 MB of VRAM leaves it 1 MB shy of what's needed for dual-page, true-color displays.

Our best-overall rankings identified the speed leaders, without concern for price. Our low-cost rankings were limited to boards priced below $1800. Not surprisingly, these boards offer slower response times than the higher-priced boards, but they sell for about $700 less.

Our tests showed only modest performance differences among the boards ranked as best overall. If you don't need the absolute best performance, the lower-cost SuperMac Spectrum/24 PDQ Plus may offer better value than the Radius PrecisionColor Pro.

The top two product families, the accelerators from Radius and SuperMac Technology, provide an interesting contrast in design philosophies (the SuperMac/E-Machines Ultura LX is a SuperMac design, so these comments apply to it as well). The Radius adapters excel at moving photographic images to the display from memory. The SuperMac adapters, on the other hand, are outstanding at executing streams of graphics primitives, such as lines, polygons, and text. SuperMac claims to accelerate 80 percent of all QuickDraw operations, a claim that was borne out in our test results: With the exception of Radius's PrecisionColor Pro in the best-overall category, SuperMac boards consistently posted the fastest overall speeds among the ranked boards.

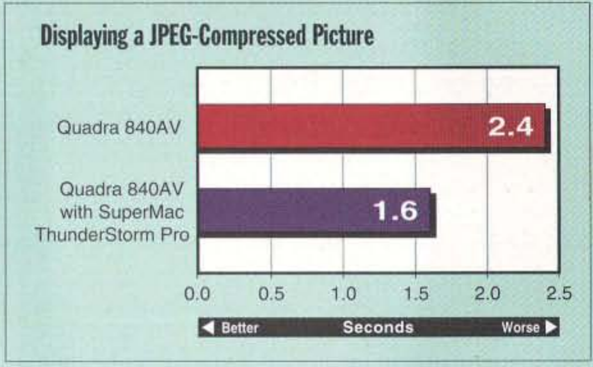
However, since just about every program does a combination of image transfers and graphics primitives, it would be fair to say that the two designs offer roughly equivalent overall performance. Users primarily interested in running Adobe Photoshop or other image-editing software will prefer a Radius adapter; the top-ranked PrecisionColor Pro moves pixels to the screen at an impressive 5.4 million pixels per second, compared to under 3 million pixels per second for all the SuperMac adapters.

The SuperMac cards offer *hardware panning,* which allows you to pan across a large desktop more quickly than you could by using the normal interface. This feature would be most useful for people who use CAD programs. Large virtual desktops force you to drop down to 8 bits of color, which limits the usefulness of this capability for graphics and publishing work. The SuperMac Spectrum/24 Series IV is ranked in the best-overall and low-cost categories, but be cautious about comparing its score directly to those of the other boards. Its top resolution is 1024 by 768 pixels, and it was tested at this resolution.

The SuperMac Thunder series of boards allow you to add memory for on-board *GWorlds* (i.e., images that exist in memory but are not displayed on-screen). This may offer an additional acceleration for applications that are written to take advantage of GWorlds, but you have to weigh the advantage of putting the memory on your display adapter rather than putting it in your system. Additional memory on the display adapter means the acceleration hardware can update off-screen images and, more important, the off-screen image can be copied to the screen without having to squeeze through the NuBus.

DSP Acceleration

Several of the SuperMac display adapters come equipped with DSPs (digital signal processors) to accelerate image-processing algorithms. The SuperMac DSP-based PhotoFlash architecture uses two AT&T DSP16A chips. SuperMac provides software to speed up existing Adobe Photoshop image-processing filters and to add new filters, including a new motion-blur filter. JPEG operations are significantly accelerated, even on a Mac Quadra 840AV, using Storm Technology's QuickPress. Using QuickPress makes JPEG practical for 160- by 120-pixel video editing using QuickTime editors such as Adobe Premiere.


Displaying a JPEG-Compressed Picture

The two offerings from Radius don't offer hardware panning, but they allow you to change the resolution of the screen without restarting your Macintosh. This might be useful if you use a 17-inch monitor, as you might want to temporarily view the entire page (at 1152 by 870 pixels) and then revert back to the normal-size image (832 by 624 pixels) to continue your design work. This feature is of no apparent use on a 21-inch monitor, however.

The RasterOps PaintBoard Turbo XL significantly lagged behind the pack in performance. It would be an especially poor choice for image-editing applications such as Photoshop; its time of 1.5 million pixels per second is less than a third of the speed of the more expensive Radius Precison-Color Pro. However, its text-display speed is better than that of the Radius boards and within 5 percent of the speed of the SuperMac boards.

All the NuBus boards slow down dramatically when displaying 16-bit images (when using 24-bit-color mode). The Radius PrecisionColor adapters move 16-bit images to the display at one-tenth the speed of 24-bit images. The SuperMac

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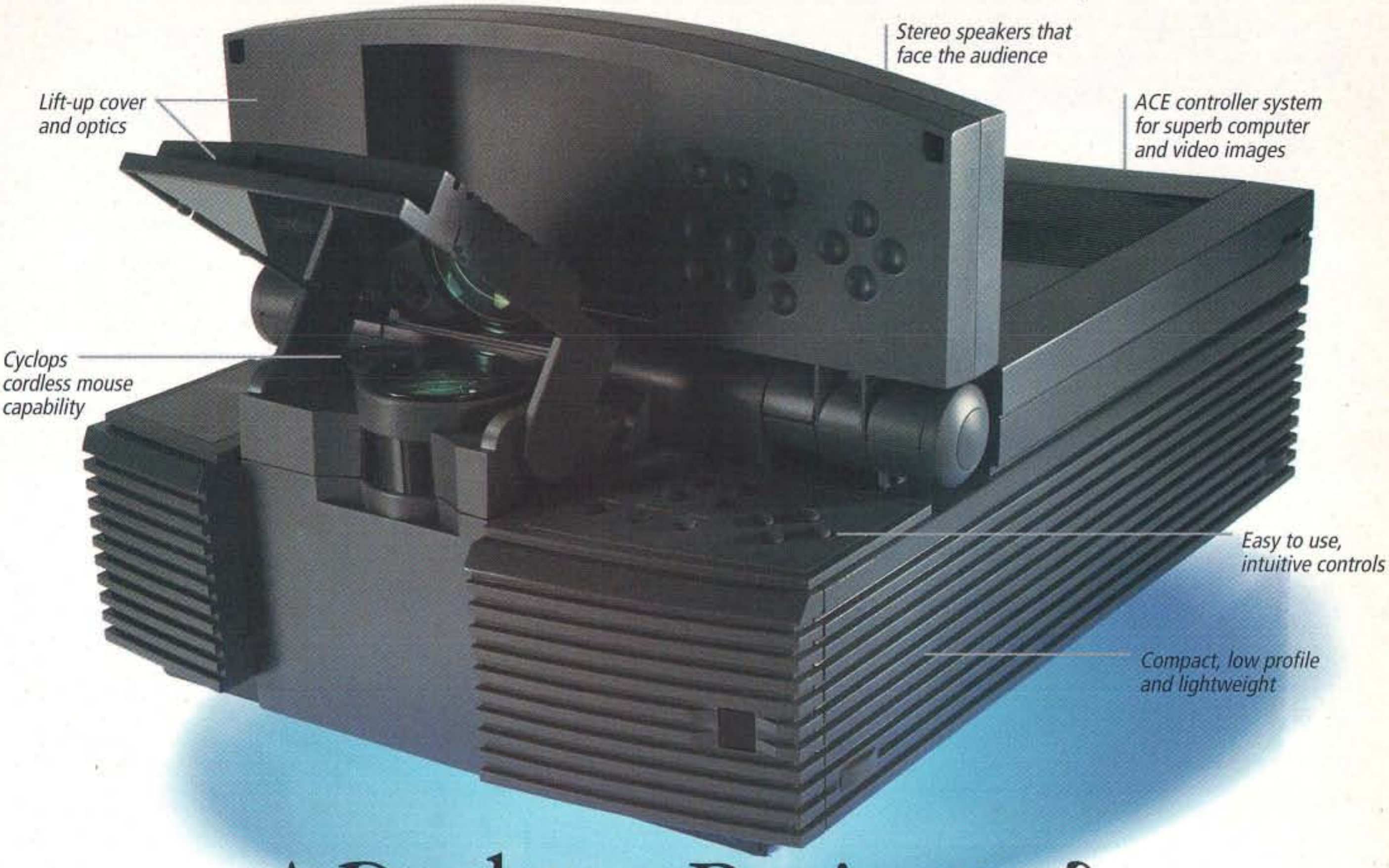
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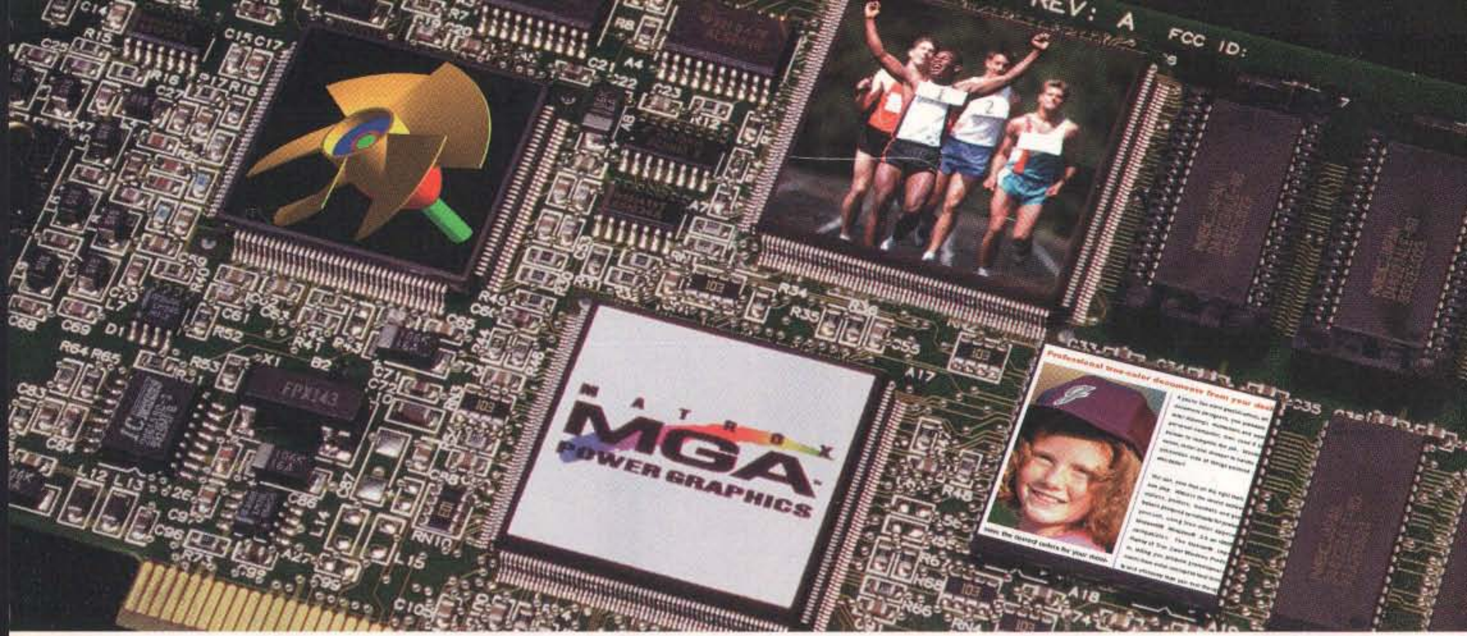

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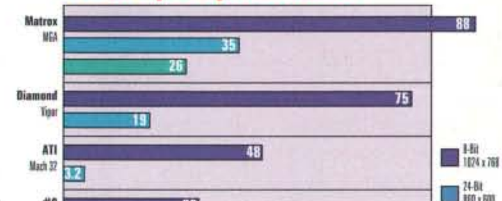
VL-Bus speed performance



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(1) Based on in-house testing of a 2 MB MGA Ultima PCI version using Ziff-Davis WinBench 3.11, Pentium 66MHz, 512K cache, 72 Hz
(2) Based on in-house testing of 2 MB VL boards using Ziff-Davis WinBench 3.11, Pentium 66MHz, 512K cache, 72 Hz. MGA and Number Nine's 1024 x 768 x 24-bit scores are based on 4 MB VL boards.

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boards move 16-bit images at about one-fifth the speed of 32-bit images. The lesson here is to be sure to switch to the color mode that matches the image that you are editing or viewing.

The performance penalty for displaying 1-, 2-, 4-, and 8-bit images is far less severe. One-bit images display at half the speed of 32-bit images on the Radius adapters and only 15 percent slower on the SuperMac adapters. The significance of this is that you can work with these lower-color images (monochrome is particularly common for desktop publishing) without resetting the colors on your monitor.

When comparing the results of the Macintosh display systems, it becomes clear that Apple is under serious attack by the Windows products for high-end graphics applications. VL-Bus adapters such as the SuperMac Spectrum/24 VL for Windows and the Media Vision Pro Graphics 1280 offer equal or better performance than our top-rated Macintosh display adapters at a fraction of the cost.

Because the tests were not identical (we used popular Mac programs to create tests for the Mac and popular Windows programs to create tests for the PC), we cannot make an overall comparison between the graphics performance of the Mac and that of the PC. But on one comparable test, the time required to copy a 32-bit image from system memory to display memory (a common operation in Adobe Photoshop), the VL-Bus adapters show a decided price/performance advantage. For example, the top-ranked PrecisionColor Pro for NuBus clocks in at 5.4 million pixels per second. The SuperMac Spectrum/24 VL for Windows produces an equally impressive 5.3 million pixels per second, but at less than half the cost.

KEY

Ease of Use:

Excellent ▲▲▲▲	Fair ▲▲
Good ▲▲▲	Poor ▲

BYTE BEST NUBUS GRAPHICS ACCELERATORS

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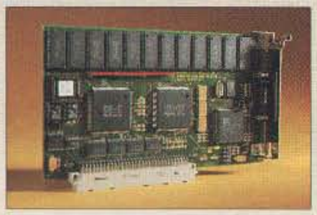

The Radius PrecisionColor Pro was the fastest Macintosh-based board overall, beating out the SuperMac Thunder cards by a narrow margin. The PrecisionColor Pro shows its biggest speed advantage when copying photographic images to the screen: At 5.4 million pixels per second, it was 80 percent faster than the Thunder II, the significantly more expensive card that won out in our rankings for high-speed imaging. For text speed, however, the PrecisionColor Pro was 33 percent slower than the Thunder II. The PrecisionColor Pro has the ability to change resolutions without requiring you to reboot the machine. The 3 MB of VRAM in our test configuration is also the maximum amount of memory that is supported by the PrecisionColor Pro.

	OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST **Radius PrecisionColor Pro**	1.349	0.243	1.881	0.186	$2499	3 MB	▲▲▲▲	Radius Custom
RUNNER-UP SuperMac Thunder/24	1.421	0.193	1.967	0.367	$2599	3 MB	▲▲▲▲	Proprietary
RUNNER-UP SuperMac/E-Machines Ultura LX	1.430	0.207	1.980	0.367	$1299	3 MB	▲▲▲▲	Proprietary
RUNNER-UP Radius PrecisionColor 24X	1.473	0.445	2.028	0.207	$2499	3 MB	▲▲▲▲	Radius Custom
RUNNER-UP SuperMac Spectrum/24 PDQ Plus	1.464	0.224	1.993	0.423	$1499	3 MB	▲▲▲▲	Proprietary

Are you cost-conscious?

LOW COST SuperMac Spectrum/24 PDQ Plus

The overall speed of the Spectrum/24 PDQ Plus beats the Raster Ops PaintBoard Turbo XL by a narrow margin. The Spectrum/24 performed especially well in tests that measured imaging and bit-map speed. The Spectrum/24's price beats that of the Raster Ops PaintBoard Turbo XL by more than $200. The performance and retail price of both cards are roughly comparable. The Spectrum/24 can provide hardware panning at less-than-24-bit color. Although the less expensive Spectrum/24 Series IV looks impressive, be aware that its maximum resolution is 1024 by 768 pixels. If you can work within this limit, the Series IV can be a good, low-cost choice, especially if fast bit-map speed is important to you.

	OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST **SuperMac Spectrum/24 PDQ Plus**	1.464	0.224	1.993	0.423	$1499	3 MB	▲▲▲▲	Proprietary
RUNNER-UP Raster Ops PaintBoard Turbo XL	1.858	0.225	2.534	0.666	$1749	3 MB	▲▲▲▲	Proprietary
RUNNER-UP SuperMac Spectrum/24 Series IV	1.450	0.313	2.057	0.298	$949	3 MB	▲▲▲▲	Proprietary

When speed matters...

HIGH-SPEED IMAGING SuperMac Thunder II

Most of the Macintoshes to appear since the Mac II are starved for NuBus slots. The Thunder II includes a dual DSP accelerator while still occupying a single NuBus slot. Even on the top-of-the-line Quadra 840AV, the board's DSP acceleration gave us a 50 percent speedup while displaying JPEG-compressed images. The DSP acceleration also speeds up image filtering in Adobe Photoshop. The Thunder II provides performance that's equivalent to that of the Radius PrecisionColor Pro and faster than that of any of the other cards we tested.

	OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST **SuperMac Thunder II**	1.400	0.182	1.953	0.334	$3999	6 MB	▲▲▲▲	Proprietary
RUNNER-UP SuperMac Thunder II Light	1.444	0.198	1.964	0.424	$2999	3 MB	▲▲▲▲	Proprietary
RUNNER-UP SuperMac ThunderStorm Pro	1.422	0.194	1.968	0.366	$3199	3 MB	▲▲▲▲	Proprietary

THE BEST GRAPHICS ACCELERATORS FOR EISA-BUS SYSTEMS

After testing six graphics cards designed for EISA, we were pleasantly surprised to find that EISA video speeds can keep up with VL-Bus speeds. We still believe that VL-Bus is the best choice for graphics performance, but some EISA systems, notably Compaq's M series, lack a local bus. For those systems, cards such as the Compaq QVision 1280/E are competitive with the best of the breed for any bus attachment.

Users of EISA systems can also consider ISA-based video accelerators, and we found that these boards usually work flawlessly in an EISA system. Accordingly, we considered the entire sampling of EISA and ISA cards for all awards in this section. Nevertheless, our tests show that while they are compatible with EISA systems, ISA boards are slower and less flexible than EISA boards, which can fully participate in EISA's automatic configuration scheme. (The EISA version of the Appian Renegade 1280 didn't arrive in time for testing.)

A major advantage of the EISA bus over ISA is the 32-bit address space (4 GB), compared to 24 bits (16 MB) for ISA. Compaq's ISA-based QVision 1280/I in particular requires a large chunk of the ISA address space; using this board limits your overall ISA system memory to 12 MB.

The QVision 1280/E earned our highest rankings for general-purpose and CAD/CAM. With even IBM now moving to third-party graphics designs, Compaq is one of the last system vendors to make its own video accelerators and write its own drivers. The QVision 1280/E is a remarkable success; it dominated all the other cards in the 256-color graphics modes. However, its drivers for 64,000 colors are newer and not as well tuned. Consequently, it placed only sixth in those tests.

The QVision 1280/E gains much of its speed through highly tuned drivers; it was one of the few cards to quickly handle a display of a 24-bit DIB (device-independent bit map). By mapping the entire VRAM into the system-address space, the QVision 1280/E saves time that would otherwise be spent paging memory over other designs.

For the best general-purpose alternatives to the QVision 1280/E, look to the ISA cards we've ranked. At $199, the Paradise/Western Digital Accelerator 24 offers good value as a low-cost general-purpose card for EISA systems. The Hercules Graphite Pro HG310 and the Volante Warp20-2 are nearly twins. Both are ISA boards based on IIT AGX accelerators and provide 1 or 2 MB of VRAM at similar prices.

Both of these boards are also competitive choices for the best direct-color and CAD/CAM boards. (Their maximum 2 MB of memory is not enough for serious color publishing applications, however.) We give a slight edge to the Graphite Pro HG310 here because of its broad range of support options, the strength of its bundled utilities, and its better performance.

The Appian Renegade 1280 was our choice for 64,000 colors on VL-Bus and ISA, and EISA is no exception. The 8-bit drivers for the ISA-based Renegade 1280 are uninspired; displaying a 24-bit DIB takes a whopping 22 seconds in 1024 by

How Bus Architecture Affects Graphics

The effect of the different buses on graphics performance is modest when using typical business applications. Our tests showed similar performance among boards for various bus architectures at 256- and 64,000-color resolutions. This changes, however, at 16-million-color resolutions, where the VL-Bus demonstrates at least a 25 percent improvement.

Applications usually draw an image directly into video memory. The amount of data that's required to pass through the bus at any given time for this operation is well within the bandwidth of the 16-bit ISA bus. However, some applications will draw an image outside of video memory as well and then transfer that image into video memory when necessary. This requires large blocks of data to pass through the bus, and the more advanced buses have an advantage over ISA.

ISA

Market forces made the original bus for the IBM PC a de facto standard. The performance of graphics adapters in an ISA bus is still acceptable, even compared to the more advanced bus technologies. However, in applications where extensive raw pixel copying from system memory to video memory is required, the ISA bus just can't keep up with VL-Bus or EISA.

Users with ISA systems that contain more than 12 MB of memory find that many of the new ISA graphics adapters either won't run or perform miserably. Since the video memory won't fit cleanly into the 16-MB limit, the board will fail or the driver has to perform acrobatics to access the memory.

EISA

ISA adapters can work in an EISA system; however, EISA-specific adapters can take advantage of the 32-bit address and data capabilities as well as the 33-MHz operating speed of that bus. Sharing interrupts and DMA channels, bus mastering, and other features make the EISA (and Micro Channel as well) superior to the ISA bus in performance and abilities. Consequently, true 32-bit EISA graphics adapters will demonstrate marked performance gains over ISA in pixel copies from system to video memory.

VL-Bus

VESA designed its local-bus specification for the 32-bit Intel 486 processor. Consequently, a VL-Bus on a non-486-processor-based system cannot reside directly on the local bus. Instead, it uses a separate layer of hardware that converts the non-486 local bus to the VESA specification. This layered implementation is very similar to that of the PCI bus. The biggest limitation of the VL-Bus is loading. Adding peripherals to the bus causes signal degradation. The faster the bus, the fewer the number of peripherals that will operate reliably. In application, the VL-Bus will support up to three peripherals running at 33 MHz.

PCI

To avoid the processor dependency of the local bus, Intel developed the PCI (Peripheral Component Interconnect) specification, a bus design that interfaces to any local bus. It uses a hardware layer that isolates the PCI from the CPU local bus and operates at 33 MHz instead of the speed of the processor. The processor's independence also allows PCI adapters to operate in non-Intel-processor systems that have the PCI bus.

PCI provides specifications for 32- and 64-bit interfaces, which should meet performance demands through the end of the century. Another feature of the PCI specification is the self-configuration of installed products, which gives users the benefit of plug-and-play. Although PCI is still in its infancy (as demonstrated in our tests), a committee consisting of about 200 companies, including Apple, is clearly driving the PCI standard forward.

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768 resolution, and 37 seconds in 1280 by 1024 resolution. The 16-bit (64,000 colors) drivers, however, are a masterpiece, displaying the same 24-bit DIB in only four-tenths of a second. The Renegade 1280 ISA was one of the few adapters that were faster using 64,000 colors than they were using 256 colors. The Renegade 1280 uses Appian's own accelerator technology.

A more polished, though somewhat slower, board is the ATI Graphics Ultra Pro EISA. Like the Renegade 1280 ISA, the Graphics Ultra Pro shines its brightest using 16-bit, direct color. The Graphics Ultra Pro could not match the Renegade 1280's overall speed, but it was significantly faster at Blting (i.e., making raw pixel copies from memory to screen): 3.5 million pixels per second for the Graphics Ultra Pro, compared to 2.5 million pixels per second for the Renegade 1280. (An EISA version of the Renegade 1280 would probably be faster, however.)

Blting performance is the all-important parameter for multimedia applications and image-editing applications. Considering ATI's advanced support for Video for Windows, the Graphics Ultra Pro looks like a natural for people with a special interest in multimedia. The Graphics Ultra Pro is based on ATI's own Mach 32 accelerator.

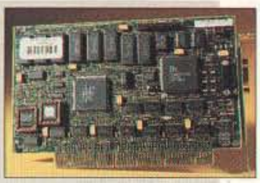
The main alternative to the QVision 1280/E for CAD/CAM applications is the Sigma WinMach 1600. The WinMach 1600 is our CAD/CAM choice for ISA systems, but it can't match the speed of the QVision 1280/E on EISA systems. (S3 has an improved driver in the works, but it was in beta at the time of our tests.) The WinMach 1600 offers the added enticement of hardware panning, a 1600- by 1200-pixel desktop, and a strong package of special imaging utilities.

BYTE BEST | EISA-BUS GRAPHICS ACCELERATORS

Need to speed business applications?

GENERAL PURPOSE

Compaq QVision 1280/E



This accelerator was the equal of better-known designs and fast enough to be on a par with VL-Bus video accelerators. Like all non-VL-Bus boards, the QVision 1280/E has relatively poor pixel-copy speeds, but its speed in displaying text and complex graphics is among the fastest of any board.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Compaq QVision 1280/E	0.641	▲▲▲	$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Paradise/W D Accelerator 24	0.733	▲▲	$199	1 MB	WD90C31	✓	✓	✓	
RUNNER-UP	Hercules Graphite Pro HG310	0.744	▲▲▲	$399	1 MB	IIT AGX015	✓	✓	✓	
RUNNER-UP	Volante Warp20-2	0.766	▲▲▲	$499	1 MB	IIT AGX-14/15	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro EISA	0.859	▲▲▲	$549	1.5 MB	ATI Mach 32	✓	✓	✓	✓

EISA leaders in 64,000 colors

DIRECT COLOR

Appian Renegade 1280 ISA

Although we tested the ISA version of the board here, the Renegade 1280 was 17 percent faster than the second-place ATI Graphics Ultra Pro EISA. The Renegade 1280 is not without warts: It is one of the few cards that requires a driver to be loaded during the DOS boot.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Appian Renegade 1280 ISA	0.659	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro EISA	0.769	▲▲▲	$549	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP	Compaq QVision 1280/E	0.859	▲▲▲	$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Nth Graphics Nth Edge 1280	0.787	▲▲▲	$995	2 MB	Chips & Technologies 481	✓		✓	
RUNNER-UP	Sigma Designs WinMach 1600	0.832	▲▲▲	$995	2 MB	S3 86C928		✓	✓	

Want the best for true-color work?

DESKTOP PUBLISHING

SuperMac Spectrum/24 EISA

The Spectrum/24's 1152 by 910 resolution with 16.7 million colors makes a good match for programs such as QuarkXPress and Adobe Photoshop. The other boards ranked here offer credible performance.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	SuperMac Spectrum/24 EISA	1.058	▲▲	$999	3 MB	Proprietary			✓	
RUNNER-UP	Raster Ops PaintBoard PC	1.963	▲▲▲	$999	3 MB	S3 86C924	✓		✓	
RUNNER-UP	Number Nine #9GXE	2.700	▲▲▲	$895	4 MB	S3 86C928		✓	✓	

For high resolution and speed...

CAD/CAM

Compaq QVision 1280/E

The 1280/E's performance puts it in the league of VL-Bus graphics adapters, but its main drawback is the 2-MB maximum VRAM, which limits resolution compared to the more expensive 3- and 4-MB boards.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Compaq QVision 1280/E	0.687	▲▲▲	$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Sigma Designs WinMach 1600	0.808	▲▲▲	$995	2 MB	S3 86C928		✓	✓	
RUNNER-UP	Pixelworks WhirlWin-II	0.815	▲▲▲	$895	2 MB	S3 86C928	✓	✓	✓	✓
RUNNER-UP	Appian Renegade 1280 ISA	0.886	▲▲▲	$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro EISA	0.948	▲▲▲	$549	2 MB	ATI Mach 32	✓	✓	✓	✓

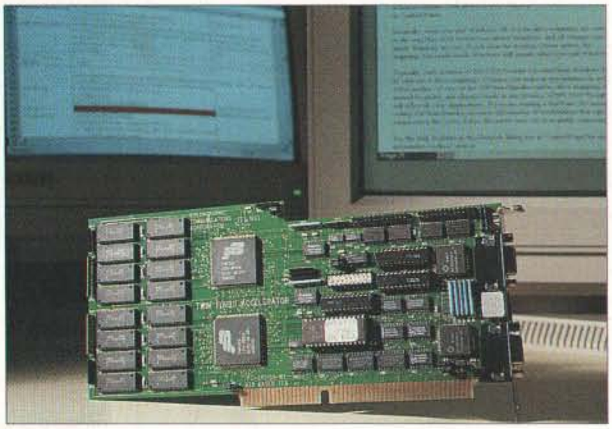
*SCO Open Systems' version of the X Window System.

KEY

Ease of Use:

Excellent ▲▲▲▲	Fair ▲▲
Good ▲▲▲	Poor ▲

HONORABLE MENTIONS



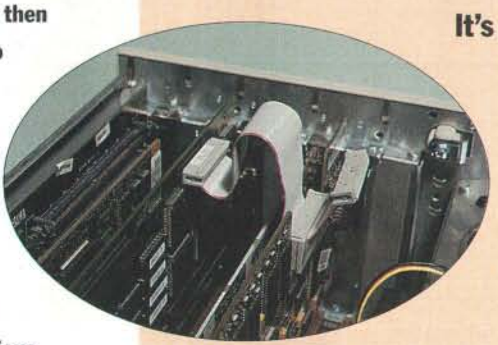
The Colorgraphic Twin Turbo gives not one, but two accelerated displays. Two VGA connections support two monitors: The Windows driver stretches the desktop across both monitors so that windows can be dragged seamlessly from one monitor to the next as if you had one big monitor.

There's a variety of ways to tell your software how fast your monitor can be refreshed, but the best we've seen is the mode-selection utility that's shipped with the Elsa Winner adapters. The Winner 1000VL board lets you choose the refresh rate via a Windows control panel and then conducts a test to make sure your choice will work. An incorrect setting causes the screen to flash for a few seconds and then revert to the previous setting, allowing you to try another selection. Other products force you to restart Windows, making it difficult to reset your video settings using the control panel if you've made an incorrect selection.

Hercules excels at the little touches that differentiate its products from similarly priced and performing competitors. One of the company's latest innovations is a utility that determines the maximum refresh rate of your monitor. Setting your video adapter to use a vertical refresh rate higher than what the monitor can accept can cause physical damage to the monitor. Users can easily configure the Hercules boards for the best picture.

The Appian Renegade 1280 offers top-notch Windows performance and, as an added bonus for software developers, can run two-screen "hard-mode" Windows debuggers such as MultiScope, Soft-Ice/W, and Turbo Debugger. Just hook any VGA monitor to the VGA port and connect your 17- or 21-inch monitor to the Renegade 1280's unique IGC port: Your debugger appears on the VGA screen while Windows gets the high-resolution screen.

Dubious Achievements



It's annoying to find that some display adapters for the PC market do not integrate VGA support, but the SuperMac Spectrum/24 adapters and the Nth Edge 1280 all require you to purchase a separate VGA adapter with a feature connector and connect the two adapters via a pass-through cable. This is no fun to install, ◁ and the VGA card takes up its own slot.

The Appian Renegade 1280 adapters are among the few that actually require you to read the manual to install them. The back plate of each Renegade 1280 card has two connectors, labeled "VGA" and "IGC." Connecting the monitor to the VGA connector allows the machine to boot and run in VGA mode, but the monitor goes totally black when you start Windows. To use both DOS and Windows, you must connect the monitor to the IGC connector instead (the manual sheds no light on the meaning of *IGC*). Once you're able to get the board up and running, however, we find the IGC connector to be of great value (see Honorable Mentions).

Introducing Audio/VideoBlender...

twice the blast, half the slots.

Now, for the first time, you can get single-frame and full-motion video capture with 16-bit audio on a single board!

AITech's new Audio/VideoBlender provides this double blast in one. Receive the same high-quality sound of the leading audio board. Plus full-motion video capture. All on one board!

Audio/VideoBlender eliminates the need for a separate audio card for capturing, digitizing and playing back video and sound. Saving an expansion slot. And, the additional cost of purchasing individual video and audio boards.

With one integrated audio/video board, compatibility issues also decrease. Spend time on producing videos rather than configuring audio and video boards.

So, with Audio/VideoBlender, create and edit videos for business and home presentations with not only full-motion video, but 16-bit PC audio. Display color resolutions of 16-bit (64K) colors, 15-bit (32K) colors or 256 colors are available. Plus, connectors for NTSC or PAL signals. Conversion from the AITech format to various video capture formats including Microsoft AVI and Intel Indeo is also provided.

For increased sound impact, Audio/VideoBlender offers 16-bit digital recording with stereo line-in and microphone input. Up to two simultaneous audio source inputs with software selection control for microphone input or audio line-in are also available.

If audio functions aren't a requirement, AITech offers the VideoBlender. All the features of the Audio/VideoBlender are offered except built-in audio.

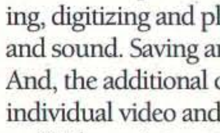
AITech can assist you with other desktop video needs too. We offer a complete line of fully compatible DTV products, including integrated audio/video output, compression and genlock/overlay products, and audio/video encoders.

For a double blast in one, or information on our other products, contact your local dealer or call us at 1-800-882-8184 or 1-510-226-8960, or fax 1-510-226-8996.

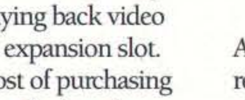
AITech International, 47971 Fremont Blvd.,
Fremont, CA 94538

AITech

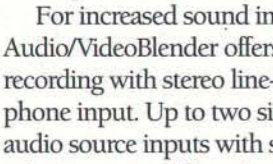
Audio/VideoBlender



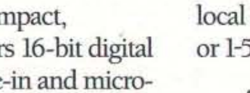
VideoSurge



WaveWatcherTV



audioSHOW



gamePlayerTV

ProPC/TV Plus

Vision for Multimedia

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Circle 66 on Inquiry Card.

ROLL CALL OF ACCELERATORS

		IMAGE-RENDERING TIME (AVERAGE, IN SECONDS)[1]								
VENDOR	MODEL	1024×768; 256 COLORS	1024×768; 64,000 COLORS	1024×768; 16 MILLION COLORS	1280×1024; 256 COLORS	PRICE (WITH RAM AS TESTED)	RAM AS TESTED (MB)	BASE RAM (MB)	MAXIMUM RAM	RAM TYPE (MB)
VL-BUS										
Actix Systems, Inc.	Graphics Engine 32i VL	0.707	0.767	—	0.812	$319	2	2	2	DRAM
Actix Systems, Inc.	ProStar VL	0.958	—	—	—	$179	1	1	2	DRAM
Actix Systems, Inc.	Ultra VL plus/2MB	0.720	—	—	—	$495	2	2	2	VRAM
Advanced Integration Research	AView2V	0.917	1.010	—	1.165	$250	2	1	2	DRAM
Alaris, Inc.	Tomahawk	0.947	—	—	—	$139	1	1	1	VRAM
American Megatrends, Inc.	Fastview VLB	0.801	0.888	—	0.952	$385	2.5	1.5	2.5	VRAM/
Appian Technology	Renegade 1280 VL Pro	0.708	0.650	—	0.821	$490	2	2	2	VRAM
ATI Technologies, Inc.	Graphics Ultra Pro VLB	0.785	0.780	—	1.004	$499	2	2	2	VRAM
Boca Research, Inc.	Vortek VRAM Local Bus	0.739	0.931	—	0.910	$625	2	1	2	VRAM
Cardinal Technologies	VideoSpectrum VL	0.957	—	—	—	$199	1	1	2	DRAM
Cardinal Technologies	WarpSpeed VL90/2MB	0.749	0.903	—	0.947	$599	2.5	1.5	2.5	VRAM/
Diamond Computer Systems, Inc.	SpeedStar Pro VLB	0.958	—	—	—	$179	1	1	1	DRAM
Diamond Computer Systems, Inc.	Stealth Pro VLB	0.799	0.918	—	—	$449	2	1	2	VRAM
Diamond Computer Systems, Inc.	Viper VLB	0.667	0.880	—	0.827	$499	2	2	2	VRAM
Elsa, Inc.	Winner 1000 VL	0.958	—	—	1.176	$449	2	1	2	VRAM
Focus Information Systems, Inc.	Cheetah XL 5428	0.955	—	—	—	$179	2	1	2	DRAM
Focus Information Systems, Inc.	Truespeed/W32	0.698	—	—	—	$169	1	1	1	DRAM
Focus Information Systems, Inc.	Truespeed/W32i	0.695	—	—	—	$229	1	1	2	DRAM
Genoa Systems Corp.	VideoBlitz	0.759	0.886	—	0.959	$549	2	2	2	VRAM
Genoa Systems Corp.	WindowsVGA 24 Turbo 8500 VL-28	0.953	—	—	—	$229	1	1	2	DRAM
★ **Hercules Computer Technology**	**Dynamite VL Pro D602**	**0.697**	**—**	**—**	**—**	**$299**	**2**	**2**	**2**	**DRAM**
Hercules Computer Technology	Graphite VL Pro HG720	0.683	0.775	—	0.852	$549	2	2	2	VRAM
Matrox Electronic Systems	MGA Impression/3/V	0.721	0.701	0.779	0.795	$1299	3	3	3	VRAM
Matrox Electronic Systems	MGA Impression/3/V/H	0.768	0.707	0.770	0.811	$1499	3	3	3	VRAM
Media Vision	Pro Graphics 1280	—	—	0.839	—	$995	4	4	4	VRAM
Nth Graphics, Ltd.	Nth S3 Advantage/VL	0.983	—	—	—	$695	1	1	2	DRAM
Orchid Technology	Celsius VLB	0.908	—	—	—	$349	1	1	2	VRAM
Orchid Technology	Fahrenheit VA/VLB	1.068	—	—	—	$349	1	1	2	DRAM
Paradise/Western Digital	Accelerator VL Plus	0.752	—	—	—	$299	1	1	2	DRAM
Sigma Designs, Inc.	Concorde VLB	0.700	—	—	—	$349	1	1	2	DRAM
SixGraph Computing, Ltd.	Wizard 9000VL	0.758	0.889	—	0.963	$550	2	2	2	VRAM
STB Systems, Inc.	Horizon VL	0.991	—	—	—	$159	1	1	1	DRAM
STB Systems, Inc.	Pegasus VL	0.828	0.957	1.015	1.004	$849	4	4	4	VRAM
STB Systems, Inc.	PowerGraph VL24	0.830	—	—	—	$199	1	1	1	DRAM
SuperMac Technology	Spectrum/24 VL for Windows	—	—	0.798	—	$999	3	3	3	VRAM
Volante, Inc.	Warp10LB	0.975	—	—	—	$399	1	1	2	DRAM
ISA										
Appian Technology	Renegade 1280 ISA	0.788	0.659	—	0.886	$490	2	2	2	VRAM
ATI Technologies, Inc.	Graphics Ultra Pro ISA	0.781	0.803	—	0.967	$499	2	2	2	VRAM
Boca Research, Inc.	SuperX Accelerator VGA	1.087	—	—	—	$219	1	1	2	DRAM
Boca Research, Inc.	Vortek VRAM Accelerator	0.923	—	—	—	$595	1	1	2	VRAM
Cardinal Technologies	VideoSpectrum XL	0.945	—	—	—	$149	1	1	1	DRAM
Colorgraphic Communications	Twin Turbo Accelerator	1.235	—	—	1.616	$1195	2	1	2	VRAM
Compaq Computer Corp.	QVision 1280/I	0.721	0.840	—	0.857	$599	2	2	2	VRAM
Hercules Computer Technology	Graphite Pro HG310	0.744	—	—	—	$399	1	1	2	VRAM
Nth Graphics, Ltd.	Nth Edge 1280	0.909	0.787	—	1.145	$995	2	2	2	VRAM
Number Nine Computer Corp.	#9GXE	—	1.093	2.700	—	$895	4	4	4	VRAM
Orchid Technology	Fahrenheit VA	1.169	—	—	—	$269	1	1	1	DRAM
★ **Paradise/Western Digital**	**Accelerator 24**	**0.733**	**—**	**—**	**—**	**$199**	**1**	**1**	**1**	**DRAM**
Paradise/Western Digital	Paradise Accelerator Pro	0.832	—	—	—	$349	1	1	2	VRAM
Pixelworks, Inc.	WhirlWin/Lite	1.560	—	—	—	$450	1	1	1	VRAM
Pixelworks, Inc.	WhirlWin 1280-VGA	—	—	—	2.090	$1695	2	2	2	VRAM
Pixelworks, Inc.	WhirlWin-II	0.807	—	—	0.815	$895	2	2	2	VRAM
Raster Ops Corp.	PaintBoard PC	—	—	1.963	—	$999	3	3	3	VRAM
Sigma Designs, Inc.	WinMach 1600	0.705	0.832	—	0.808	$995	2	2	2	VRAM
SixGraph Computing, Ltd.	Wizard 924	1.214	—	—	—	$170	1	1	1	VRAM
STB Systems, Inc.	Horizon VGA	1.016	—	—	—	$159	1	1	1	DRAM
STB Systems, Inc.	PowerGraph X-24	0.865	—	—	—	$199	1	1	1	DRAM
SuperMac Technology	Spectrum/24 ISA for Windows	—	—	1.288	—	$999	3	3	3	VRAM
Volante, Inc.	Warp10+	1.128	—	—	—	$299	1	1	1	DRAM
Volante, Inc.	Warp20-2	0.766	—	—	—	$499	1	1	2	VRAM
EISA										
American Megatrends, Inc.	Fastview EISA	1.341	—	—	—	$375	1.5	1.5	2.5	VRAM/
ATI Technologies, Inc.	Graphics Ultra Pro EISA	0.859	0.769	—	0.948	$549	2	2	2	VRAM
Compaq Computer Corp.	QVision 1024/E	0.835	1.506	—	—	$509	1	1	2	VRAM
★ **Compaq Computer Corp.**	**QVision 1280/E**	**0.641**	**0.859**	**—**	**0.687**	**$599**	**2**	**2**	**2**	**VRAM**
Elsa, Inc.	Winner 1000 EISA/ISA[4]	0.996	—	—	1.266	$449	2	1	2	VRAM
SuperMac Technology	Spectrum/24 EISA for Windows	—	—	1.058	—	$999	3	3	3	VRAM

VENDOR	MODEL	1024×768; 256 COLORS	1024×768; 64,000 COLORS	1152×870; 16 MILLION COLORS	1280×1024; 256 COLORS	PRICE (WITH RAM AS TESTED)	RAM AS TESTED (MB)	BASE RAM (MB)	MAXIMUM RAM	RAM TYPE (MB)
NUBUS										
Radius, Inc.	PrecisionColor 24X	—	—	1.473	—	$2499	3	3	3	VRAM
★ **Radius, Inc.**	**PrecisionColor Pro**	**—**	**—**	**1.349**	**—**	**$2499**	**3**	**3**	**3**	**VRAM**
Raster Ops Corp.	PaintBoard Turbo XL	—	—	1.858	—	$1749	3	3	3	VRAM
SuperMac Technology	Spectrum/24 PDQ Plus	—	—	1.464	—	$1499	3	3	3	VRAM
SuperMac Technology	Spectrum/24 Series IV	—	—	1.450[5]	—	$949	3	3	3	VRAM
SuperMac Technology	Thunder II	—	—	1.400	—	$3999	6	6	6	VRAM
SuperMac Technology	Thunder II Light	—	—	1.444	—	$2999	3	3	3	VRAM
SuperMac Technology	Thunder/24	—	—	1.421	—	$2599	3	3	3	VRAM
SuperMac Technology	ThunderStorm Pro	—	—	1.422	—	$3199	3	3	3	VRAM
SuperMac Technology/E-Machines	Ultura LX	—	—	1.430	—	$1299	3	3	3	VRAM

★ = BYTE Best. ✓ = yes.

[1] Dashes indicate unsupported modes.

[2] Blanks indicate modes not supported as noninterlaced.

ACCELERATOR CONTROLLER	MAXIMUM RESOLUTION (NONINTERLACED)[2]			STANDARD DRIVERS							
	256 COLORS	64,000 COLORS	16 MILLION COLORS	AUTOCAD	IBM OS/2	WINDOWS 3.1	WINDOWS NT	UNIX[3]	TOLL-FREE PHONE	PHONE	INQUIRY NO.
S3 86C805i	1280×1024	1024×768	640×480	✓	✓	✓			(800) 927-5557	(408) 986-1625	1346
Cirrus Logic GD5428	1024×768	800×600	640×480	✓		✓	✓		(800) 927-5557	(408) 986-1625	1347
S3 86C928	1280×1024	1024×768	640×480	✓	✓	✓	✓	✓	(800) 927-5557	(408) 986-1625	1348
S3 86C805	1024×768	800×600	640×480	✓	✓	✓	✓	✓	(800) 866-1945	(408) 428-0800	1349
Cirrus Logic GD5426	1024×768	800×600	640×480	✓	✓	✓	✓		N/A	(510) 770-5700	1350
Weitek Power 9000	1280×1024	1024×768	800×600	✓	✓	✓			(800) 828-9264	(404) 263-8181	1351
Appian AGC98032	1280×1024	1024×768	640×480	✓	✓	✓	✓	✓	(800) 727-7426	(408) 730-8800	1352
ATI Mach 32	1280×1024	1024×768	800×600	✓	✓	✓	✓	✓	N/A	(905) 882-2600	1353
IIT AGX015	1280×1024	1024×768	800×600	✓	✓	✓			N/A	(407) 997-6227	1354
Cirrus Logic GD5428	1024×768	800×600	640×480	✓	✓	✓			N/A	(717) 293-3000	1355
Weitek Power 9000	1280×1024	1024×768	800×600	✓	✓	✓			N/A	(717) 293-3000	1356
Cirrus Logic GD5428	1024×768	800×600	640×480	✓	✓	✓	✓	✓	N/A	(408) 736-2000	1357
S3 86C928	1280×1024	1024×768	800×600	✓	✓	✓	✓		N/A	(408) 736-2000	1358
Weitek Power 9000	1280×1024	1024×768	800×600	✓	✓	✓	✓	✓	N/A	(408) 736-2000	1359
S3 86C928	1280×1024	1024×768	640×480	✓	✓	✓	✓		(800) 272-3572	(415) 615-7799	1360
Cirrus Logic GD5428	1024×768	800×600	640×480	✓	✓	✓			(800) 925-2378	(510) 657-2845	1361
Tseng Labs ET4000/W32	1024×768	800×600	640×480	✓	✓	✓			(800) 925-2378	(510) 657-2845	1362
Tseng Labs ET4000/W32i	1024×768	1024×768	800×600	✓	✓	✓			(800) 925-2378	(510) 657-2845	1363
Weitek Power 9000	1280×1024	1024×768	800×600	✓	✓	✓	✓		(800) 934-3662	(408) 432-9090	1364
Cirrus Logic CL5428	1024×768	800×600	640×480	✓	✓	✓	✓		(800) 934-3662	(408) 432-9090	1365
Tseng Labs ET4000/W32i	**1024×768**	**1024×768**	**640×480**	✓	✓	✓	✓		**(800) 532-0600**	**(510) 623-6030**	**1366**
IIT AGX015	1280×1024	1024×768	800×600	✓		✓			(800) 532-0600	(510) 623-6030	1367
Matrox MGA	1280×1024	1152×870	800×600	✓	✓	✓	✓	✓	N/A	(514) 685-2630	1368
Matrox MGA	1600×1200	1152×870	800×600	✓	✓	✓	✓	✓	N/A	(514) 685-2630	1369
Media Vision MVV451			1280×1024	✓	✓	✓	✓		(800) 348-7116	(510) 770-8600	1370
S3 86C805	1024×768	800×600	640×480	✓	✓	✓	✓		(800) 624-7552	(512) 832-1944	1371
IIT AGX015	1280×1024	1024×768	800×600	✓	✓	✓	✓		(800) 767-2443	(510) 683-0300	1372
S3 86C805c	1024×768	800×600	640×480	✓	✓	✓	✓	✓	(800) 767-2443	(510) 683-0300	1373
WD90C33	1024×768	800×600	640×480	✓	✓	✓			(800) 832-4778	(714) 932-5000	1374
Tseng Labs ET4000/W32i	1024×768	800×600	640×480	✓	✓	✓			(800) 845-8086	(510) 770-0100	1375
Weitek Power 9000	1280×1024	1024×768	800×600	✓	✓	✓	✓		N/A	(514) 332-1331	1376
Cirrus Logic GD5426	1024×768	800×600	640×480	✓	✓	✓	✓		(800) 234-4334	(214) 234-8750	1377
S3 86C928	1600×1200	1280×1024	1024×768	✓	✓	✓	✓		(800) 234-4334	(214) 234-8750	1378
S3 86C805	1024×768	800×600	640×480	✓	✓	✓	✓		(800) 234-4334	(214) 234-8750	1379
Proprietary			1152×870			✓	✓		(800) 334-3005	(408) 541-6100	1380
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Appian AGC98032	1280×1024	1024×768	640×480	✓	✓	✓	✓	✓	(800) 727-7426	(408) 730-8800	1382
ATI Mach 32	1280×1024	1024×768	800×600	✓	✓	✓	✓	✓	N/A	(905) 882-2600	1383
Cirrus Logic GD5428	1024×768	800×600	640×480	✓		✓			N/A	(407) 997-6227	1384
IIT AGX014	1024×768	800×600	640×480	✓	✓	✓			N/A	(407) 997-6227	1385
Cirrus Logic GD5426	1024×768	800×600	640×480	✓	✓	✓			N/A	(717) 293-3000	1386
S3 86C928	1280×1024	800×600	640×480		✓	✓			N/A	(404) 455-3921	1387
Proprietary	1280×1024	1024×768	640×480	✓	✓	✓	✓	✓	(800) 845-1518	(713) 378-8820	1388
IIT AGX015	1280×1024	1024×768	800×600	✓	✓	✓			(800) 532-0600	(510) 623-6030	1389
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S3 86C928	1600×1200	1280×1024	1024×768	✓	✓	✓	✓		(800) 438-6463	(617) 674-0009	1391
S3 86C801	1024×768	800×600	640×480	✓	✓	✓	✓	✓	(800) 767-2443	(510) 683-0300	1392
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IIT AGX014	1280×1024	1024×768	800×600	✓	✓	✓			(800) 832-4778	(714) 932-5000	1394
S3 86C924	1024×768	640×480		✓	✓	✓		✓	(800) 247-2476	(603) 880-1322	1395
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Proprietary	—	—	1380×1024	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1417
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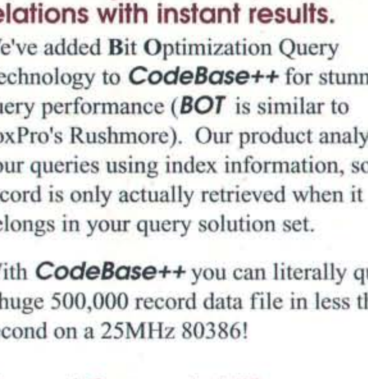
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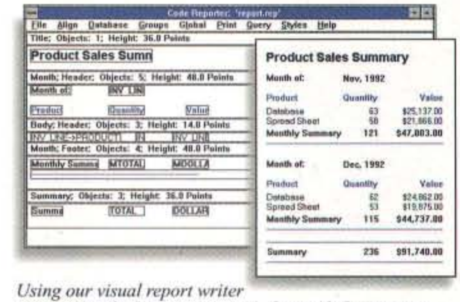

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Product Sales Summary

Month of:        Nov, 1992
Product          Quantity        Value
Database               63   $25,137.00
Spread Sheet           58   $21,866.00
Monthly Summary       121   $47,003.00

Month of:        Dec, 1992
Product          Quantity        Value
Database               62   $24,862.00
Spread Sheet           53   $19,875.00
Monthly Summary       115   $44,737.00

Summary               236   $91,740.00
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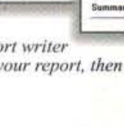

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Genetic Programming with C++

Mutating computer programs can evolve superior methods for solving loosely defined problems

ANDY SINGLETON

Could a computer create better software than you could? Could 100,000 computers do the job? Can any purely mechanical process match the creative power of the human mind? Consider natural evolution. You may design a better mousetrap, but evolution, by the simple mechanical process of blind trial and error, can design a cat.

This is the challenge of genetic programming (GP for short)—to evolve a solution that is as elegant and sophisticated as a cat on the hunt. With an improved understanding of evolution and with the power of massively parallel computers, this goal is in sight. In this article I describe GPQUICK, a simple GP system in C++.

GP is one application of an important new technology known as *genetic algorithms* (or GAs). GAs can evolve a variety of computer-based objects and solutions. They are used for optimization—producing a better route map, a more efficient manufacturing schedule, or a more cost-effective alloy mixture. They can be used for interactive evolution: teamwork between a person and a machine to design pictures, buildings, or machines. And they can provide a superior method of computer learning for speech, vision, financial trading, fault detection, and so on.

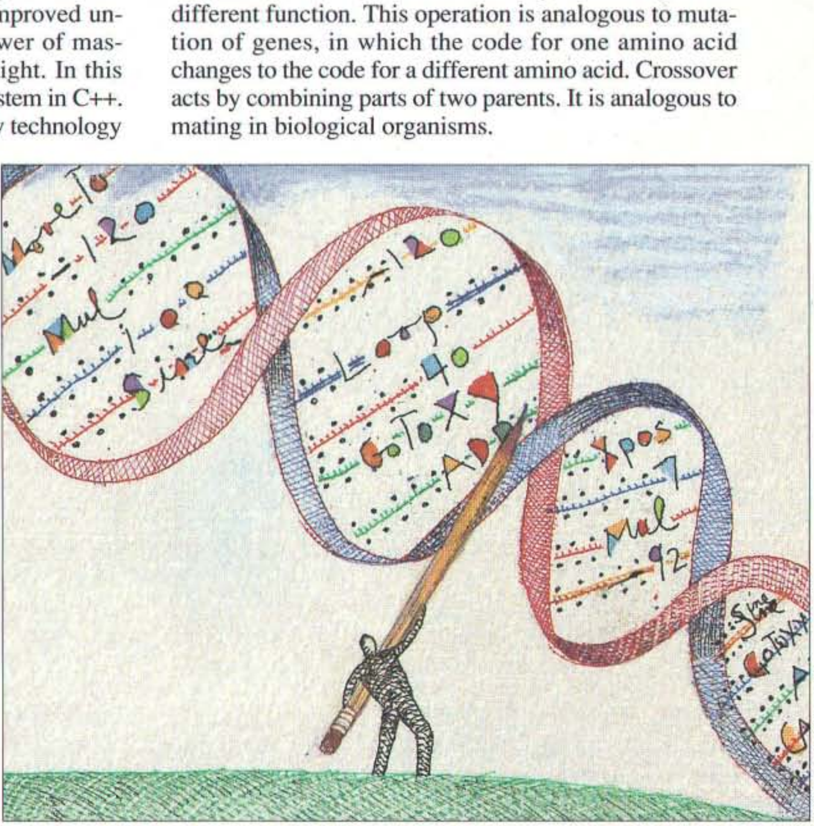
How Does a GA Work?

A GA is a simple tactic for computer learning that is inspired by natural evolution. The computer produces a whole population. It then picks the best "individuals" and changes them, producing a new population of variations on the best individuals, with the hope that some of the new individuals will be even better. If this simple process is carried on for many generations, the results can be impressive.

A GA is simple; it is just a form of trial and error, with two elements making it more effective. The first is that it tries out variations of only the best individuals, making it more likely to be trying something good. The second is that it builds a good solution piecewise. It uses crossover (or mating) to combine the good parts of one individual with the good parts of another.

A genetic algorithm consists of three operations: *evaluation*, *selection*, and *reproduction*. Evaluation is the process of assigning a fitness score so you can find the best individuals. You need to make a fitness function that scores the output from each individual. Next, you select the individuals to be used as parents for the next generation. An automated GA usually picks the individuals with the highest fitness scores. Last, you reproduce those parents with genetic operations to generate new and possibly better individuals in the next generation.

The two main classes of genetic operations are *mutation* and *crossover*. Mutation operates on a single parent by randomly changing some part of it. For instance, a 1 might be changed to a 0, a number might be changed to another number, or a function might be changed to a different function. This operation is analogous to mutation of genes, in which the code for one amino acid changes to the code for a different amino acid. Crossover acts by combining parts of two parents. It is analogous to mating in biological organisms.



ALAN E. COBER © 1994

How Can a GA Be Used for Programming?

If you can define selection, mutation, and crossover operators, you can use a GA to generate almost anything. GP is simply the application of a GA to generate computer programs. Numerous computer languages or representations have been tried, with varying degrees of success.

In 1975, John Holland, the inventor of GAs, proposed a form of GP known as a *classifier system*. Classifiers are IF...THEN rules, such as "If you fall down, then cover

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CHROME AND FUNCTION CLASSES

CLASS Chrome

IMPORTANT DATA STRUCTURES

```
// Stack (Instruction) pointer
int ip;

// Actual GP code
node *expr;

// Fitness on last eval
float lastfitness;

// Array of pointers to Functions from
// the current Problem
Function** funclist;

// Initialization and evaluation
// parameters
ChromeParams* params;
```

IMPORTANT MEMBER FUNCTIONS

```
// Initialize a new chrome with random
// "ramped half and half" expression.
Chrome(ChromeParams* p,CFitness* cf,
    Function** f,retval* c);

// Eval the expression at ip.
retval eval() {
    ip++;
    return funclist[FUNCNUM(stack[ip])]->eval(this);
    } ;
// Eval the whole expression.
retval evalAll() ;

// Cross with mate and return a new chrome.
Chrome* CrossTree(Chrome* mate);
// Mutate self.
void Mutate();

// Write the expression to a stream.
void write(int pretty, ostream& ofile = cout);
// Read and parse an expression
int Load(istream& istr);
```

CLASS Function

IMPORTANT DATA STRUCTURES

```
// Written name
char name[30];

// Number of arguments. Used to initialize
// and traverse arguments.
int argnum;

// Number of variables in variable table
// of op code. Used to initialize node.idx.
int varnum;

// Selection frequency relative to other
// functions. Used in initialization, mutation.
int weight;

// Pointer to evaluation code. Not a virtual
// for speed reasons.
EVALFUNC evalfunc;
```

IMPORTANT MEMBER FUNCTIONS

```
// Active ingredient
retval eval(class Chrome* st) {
  return (evalfunc)(st);
  };
```

your face." These rules can be represented as strings of 1s and 0s. For instance, a bit could represent whether you (1) are or (0) are not falling down, and another bit could represent whether or not you should cover your face. A GA can evolve these strings by testing them for effectiveness under a variety of circumstances and then reproducing the most effective ones with mutation and crossover.

In 1985, Nicheal Kramer proposed evolving computer program code directly and demonstrated the evolution of simple arithmetic expressions. He also proposed a tree representation with the special form of crossover used in GPQUICK.

John Koza demonstrated the evolution of Lisp expressions that are actually computer programs in 1987. He started using the term *genetic programming* to describe this process. In 1989 he applied for a patent on the use of GP for evolving a wide variety of applications. Like many software patents, it is controversial. Koza has written a book called *Genetic Programming: On the Programming of Computers by Means of Natural Selection & Genetics* (MIT Press, 1992) that details numerous GP experiments and provides practical advice.

S-expressions, more commonly known as Lisp expressions, have become the mainstream GP representation. Researchers are investigating other GP representations, including object structures, direct evolution of machine code, and the design of processors and machine languages that would be amenable to GP.

S-Expressions Make You Lisp

The form of GP that Koza described and GPQUICK uses generates S-expressions. An S-expression consists of a function followed by zero or more arguments. Each argument is in turn also an S-expression. You can represent "2+2" as `(ADD 2 2)`, and "2+3∗5/2" as `(ADD 2 (MULTIPLY 3 (DIVIDE 5 2)))`.

A function in an expression is called a *node*. Functions with no arguments, such as numeric constants, are called *terminals*. All functions return some value. Functions can also perform actions, otherwise known as *side effects*. You could have functions like `(TURN_RIGHT)`, `(TURN_RIGHT number_of_degrees)`, and so on, which give S-expressions procedural abilities.

The `PROG` function can string actions together into a procedural program, such as `(PROG GO_FORWARD GO_FORWARD TURN_RIGHT)`. If you add conditionals such as `(IF condition do_this otherwise_do_that)`, looping constructs such as `(WHILE condition do_this)` or `(FOR count do_this)`, and a memory array with `(SET element value)` and `(GET element)`, you have a Turing complete programming language that can represent any structured program.

Achieving Closure

To do GP, you chop a piece off one program and stick it together with a piece of another program, on the off chance that something good may result. If you tried this with one of your C++

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programs, you'd have approximately a 0 percent chance of creating a working program. With S-expressions, though, you can rig the game so that you have a much higher probability of success.

You design your functions so that they all return the same argument type, usually a floating-point number, and they all accept arguments of this type. This situation is called *closure*. Now you can use any expression as an argument for any other expression. You can swap a subexpression from one program for a subexpression in another program and always end up with a syntactically valid program. It might be completely useless, but it will never send smoke billowing out from under the CPU.

Crossover

GPQUICK uses subtree crossover. First you select two parents. Then you pick a node, any node, from the first parent. This node is, by definition, the beginning of some complete subexpression. If you wrote the expression out as a parse tree, the subexpression would be a branch or subtree. You extract this, leaving a hole in the program. You then pick a node in the second parent, extract the following subexpression, and swap it with the first subexpression.

For example, I could cross `(ADD 2 (MULTIPLY 3 (DIVIDE 5 2)))` with `(ADD (MULTIPLY 7 11) 23)`. In the first parent, I pick the fourth node, `3`. In the second parent, I pick the second node, or `(MULTIPLY 7 11)`. Swapping, I end up with `(ADD 2 (MULTIPLY (MULTIPLY 7 11) (DIVIDE 5 2)))`.

Mutation

Any random change to a program qualifies as a mutation. There are many types of changes that you can make to an S-expression and still end up with a syntactically valid program. For simplicity, I have included in GPQUICK one type of mutation that picks a random function and changes it to a different function with the same number of arguments.

Applying this mutation to `(ADD 2 (MULTIPLY 3 (DIVIDE 5 2)))`, I select the third node, `MULTIPLY`, for mutation. I can change it to any two-argument function. I select `ADD` at random, ending up with `(ADD 2 (ADD 3 (DIVIDE 5 2)))`. To mutate a terminal, you would substitute another terminal.

The GP Code and the Incredible Shrinking Interpreter

GPQUICK uses a representation for the GP code called *linear prefix jump table*, which was suggested to me by Mike Keith. Programs coded this way are small and evaluate quickly. When you evaluate populations of several thousand programs, size and speed are very important.

The GP code is an array of 2-byte structures of type `node`, defined by the following:

```
typedef struct {
  unsigned char op;
  unsigned char idx;
  } node; // node type
```

Structure member `op` (for op code) is a function number. The `idx` is an immediate operand that can represent a table or a constant index. The GP code is stored in an object called a `Chrome`, short for chromosome.

In GPQUICK, functions are represented by objects of class `Function`. All the functions are stored in the array `funcarray` and given an array index. You could install the functions `NUMBER` (to return numeric constants), `ADD`, `SUBTRACT`, `MULTIPLY`, and `DIVIDE` as functions 0, 1, 2, 3, and 4. Function `NUMBER` uses the `idx` to determine which number to return. Other functions do not use `idx` and leave a zero value.

The expression `(ADD 2 (MULTIPLY 3 (DIVIDE 5 2)))` would be represented in our GP machine language as `{(1,0) (0,2) (3,0) (0,3) (4,0) (0,5) (0,2)}`, where the first element `(1,0)` is an `ADD` (op code 1) node, and the second `(0,2)` is a `NUMBER` (op code 0) node returning the value 2.

Our `Chrome` method to evaluate the function at position `ip` in the code stack looks like this:

continued

POP AND PROBLEM CLASSES

CLASS: Pop

IMPORTANT DATA STRUCTURES

```
// Allocated array holding the
// actual chromes
Chrome** pop;

// The current Problem
Problem* problem;

// Number of Chromes
UINT popsize;

// Number of individuals
// generated so far
long gencount;

// Index of current best Chrome
int   BestMember;
```

IMPORTANT MEMBER FUNCTIONS

```
// Set up a population for a particular problem.
Pop(Problem* prob,ChromeParams* par, UINT size );

// Generate a new chrome. Return its fitness. Generate until
// reaching time max_time, evaluating maxevals individuals,
// or reaching maxfitness.
virtual Chrome* generate();

virtual Chrome* go_until(time_t max_time,
  long maxevals, float maxfitness);
```

CLASS: Problem

IMPORTANT DATA STRUCTURES

```
// Array of primitive functions
Function** funclist;
```

IMPORTANT MEMBER FUNCTIONS

```
// Install the primitives and initialize the
// evaluation environment.
Problem();

// Add a Function to the funclist.
void AddF(Function* f);

// Pure virtual fitness function. It should evaluate the chrome
// in an appropriate environment and return a fitness value.
virtual float fitness(Chrome* chrome);
```

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```
ip++;return funclist[expr[ip].op]->
        eval(this);
```

This calls the appropriate `Function eval` method. The `Function eval` method calls the `Chrome eval` method recursively to get its arguments. The `eval` method for function `ADD` is as follows:

```
return chrome->eval() + chrome->eval();
```

The `eval` method for function `NUMBER` is

```
return chrome->expr[ip].idx;
```

That's all there is to the interpreter. Add functions to suit your taste.

GPQUICK Architecture

The object-oriented architecture of GPQUICK is divided into three pieces: the `Chrome` and `Function` classes, which are the underlying program representation; the `Problem` class, which holds the objectives, functions, and data necessary to define and solve a particular GP task; and the `Pop` (short for *population*) class, which holds a population of `Chromes` and runs a GA on them, calling the `fitness` function in the `Problem` to do an evaluation. This three-part architecture has worked well for me in a variety of applications.

Obviously, there is a tremendous variety of potential `Problems`. Also, many different kinds of GAs can be associated with subclasses of `Pop`, each with different methods of selection, a different mix of genetic operations, and a different topology for the population (e.g., single, parallel, or distributed processors). As long as they share the same `Chrome` representation, most `Problems` can run with most `Pops` and GAs.

The `Chrome` class is the carrier of a genetic program. A `Function` object carries information that the `Chrome` needs for initializing, displaying, and evaluating expressions that contain that function. Many functions, such as the arithmetic functions, are problem-independent; however, some functions, such as data terminals, require the data structures and evaluation environment of a particular problem. The table "Chrome and Function Classes" lists important data structures and member functions.

`Pop` carries an array of `Chromes`, evaluates them with the fitness function provided in the current `Problem`, and performs a GA to generate new and better `Chromes`. `Pop` uses a steady-state GA, generating one new `Chrome` and replacing one old one at a time, as opposed to making a whole new batch as a generation.

The `generate` method is the agent that selects one or more parents and applies mutation or crossover. This virtual method could be replaced by code with different strategies for selection, reproduction, or interaction with parallel populations. (The important data structures and member functions are listed in the table "Pop and Problem Classes.")

To do GP, you must have a fitness function that defines the problem and a set of primitive operations sufficient for solving it. Any implementation of GPQUICK must have a subclass of `Problem` that includes the appropriate fitness function and primitive functions.

Most programs need to be evaluated in a particular context. If you're trying to evolve a program that can navigate a maze, you need to define the maze. Setting up the environment should be done in the `Problem` constructor and at the beginning of the fitness function.

Is SSRProb Useful?

The default problem for GPQUICK attempts to evolve an arithmetic formula matching `John*(George-Paul)+2.5*Ringo`. This sort of problem is known as symbolic regression. Using symbolic regression to discover a function that you already know is not useful, but you can modify `SSRProb` to learn prediction and classification from real-world examples. This is called *genetic induction*, and it has several advantages compared to competing statistical or neural techniques.

To do genetic induction, set up a training database that includes the value you want to predict and fields for each of the input variables in your model. Load the training database into a memory array. Add a static variable for the current record number. Add terminals that return the input field values for the current record. In the fitness function, evaluate for a set of randomly chosen records, and calculate the error compared to the desired value. The resulting expression will hopefully return accurate values for new input examples. I use a souped-up version of genetic induction to evolve traders and list selectors.

The Future of GP

GPQUICK can produce arithmetic expressions, but it will never produce an operating system. Its successors may.

The trend to use more and faster processors will increase GP capabilities. GP consumes huge amounts of processor time evaluating millions of candidate programs. As the programs' behavior becomes more sophisticated, time spent on evaluation rises.

Fortunately, GP is ideally suited to massively parallel computers of almost any design. Just as evolution can proceed among a population that is spread out over a continent, so GP can proceed with populations that are distributed among a multitude of processors, with good individuals traveling occasionally from one processing neighborhood to the next for interbreeding. The Creation Mechanics GP toolkit supports *desktop supercomputing*, which links a network of PCs into a population for parallel processing. GP may well become a core application for the next generation of parallel computers.

As understanding of evolution and the mechanics of creation improves, so will GA effectiveness. We are working to understand specific problems; a basic problem concerns finding the right fitness function and environment for rapid evolution. We are also investigating the evolution of evolvability—finding the types of structures that respond well to mutation and crossover. Perhaps the most important question concerns modularity and hierarchy: how to build up the organs and cells, subroutines and data structures, of a genetic program.

Knowledge of the design of genetic algorithms is improving rapidly. Ultimately, we will be able to deploy an even more effective weapon—continuous, evolutionary improvement in the creative mechanism itself. We will build GP systems that can evolve a better version of themselves. This will quickly and dramatically extend GP capacity in ways that we cannot predict. We will have to call this thing by another name: artificial life. ■

Editor's note: *The source code and executable files (for MS-DOS or Microsoft Windows) are available electronically. See page 5 for details.*

Andy Singleton is president of Creation Mechanics, Inc. (Dublin, NH), a software development company specializing in genetic programming for financial analysis. He can be reached on BIX c/o "editors" or on the Internet at p00396@psilink.com.

Inside the PCI Local Bus

This new PC bus offers an industry standard, high throughput, and room for future growth

GUY W. KENDALL

The expansion bus in most of today's PCs is based on a design that's over a decade old. However, this 16-bit IBM AT bus—now called the ISA bus—was built to accommodate devices that are considered slow by modern standards. Today's multitasking operating systems and feature-rich applications require not only faster processors but better throughput to system peripherals, such as the hard drive and display hardware. The ancient ISA bus has thus become a bottleneck that chokes system performance.

The fastest bus in a computer system is the local bus, which comes out of the microprocessor. Thus, the simplest way for designers to meet the throughput requirements of ISA-bus-based PCs has been to interface fast peripherals directly to the processor. Computers have been built with graphics chips or other peripherals built onto the motherboard and tied directly to the processor's local bus.

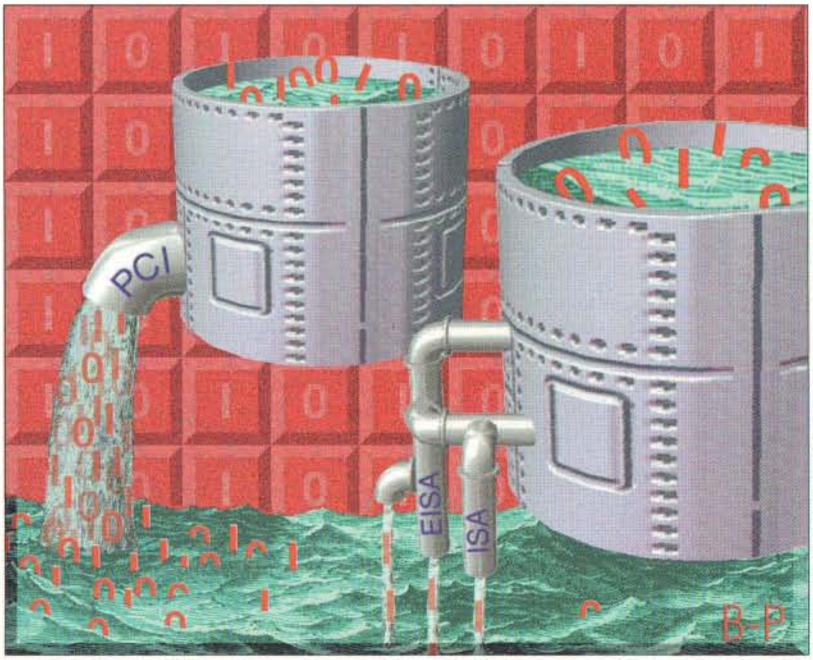
While this approach achieved the desired high throughput, it had two distinct disadvantages. First, PC vendors got caught in what is called the "processor treadmill": Because the components are so intimately tied to the processor bus, a PC's entire I/O subsystem has to be redesigned every time a faster processor becomes available. Second, users, who were stuck with having the peripherals on the motherboard, became unhappy when the fast-paced graphics market made the graphics controllers on their motherboards obsolete.

The solution was to have the graphics controller reside on expansion boards to make upgrading an easy task. This in turn drove each motherboard vendor to create its own proprietary way to connect expansion boards to the processor's local bus. This solution provided both upgradability and expandability. Unfortunately, this strategy also required users to buy new peripherals from the original motherboard supplier. De facto standards started to emerge, but there was enough chaos in the industry to warrant a true standard.

A Standard Local Bus

The PCI (Peripheral Component Interconnect) local bus is a high-performance connection between motherboard components and expansion boards. It was first proposed at an Intel Technical Forum in December 1991, and the first version of the specification was released in June 1992. The PCI Steering Committee members who developed the initial version of the specification were Compaq, DEC, IBM, Intel, and NCR. In June 1992, PCI became an open industry standard controlled by the newly formed PCI SIG (PCI Special Interest Group). In April 1993, revision 2.0 of the PCI specification was released.

Vendor support for the PCI standard has been widespread. Apple has announced that it will support the PCI bus in a future version of its PowerPC RISC Macintosh. (Note that first-generation PowerPC Macs will use the NuBus to support existing NuBus peripheral boards.) DEC intends to support PCI in its Alpha-based systems, and the company's high-speed DECchip 210066 RISC processor implements a PCI interface on the chip itself. This kind of support, in addition to that from many vendors of 80x86-based systems, paves the way for PCI to become a universally accepted component interconnect and expansion-bus standard.



LYN BOYER-PENNINGTON © 1994

The motivation for PCI was the fact that PC I/O architecture was so slow in relation to the processor that further improvements in processor technology would not have produced any noticeable improvements in overall system performance. PCI removes systems designers from the processor treadmill by isolating the I/O subsystem from the processor/memory/cache subsystem.

A fundamental part of a PCI design is the PCI-to-host

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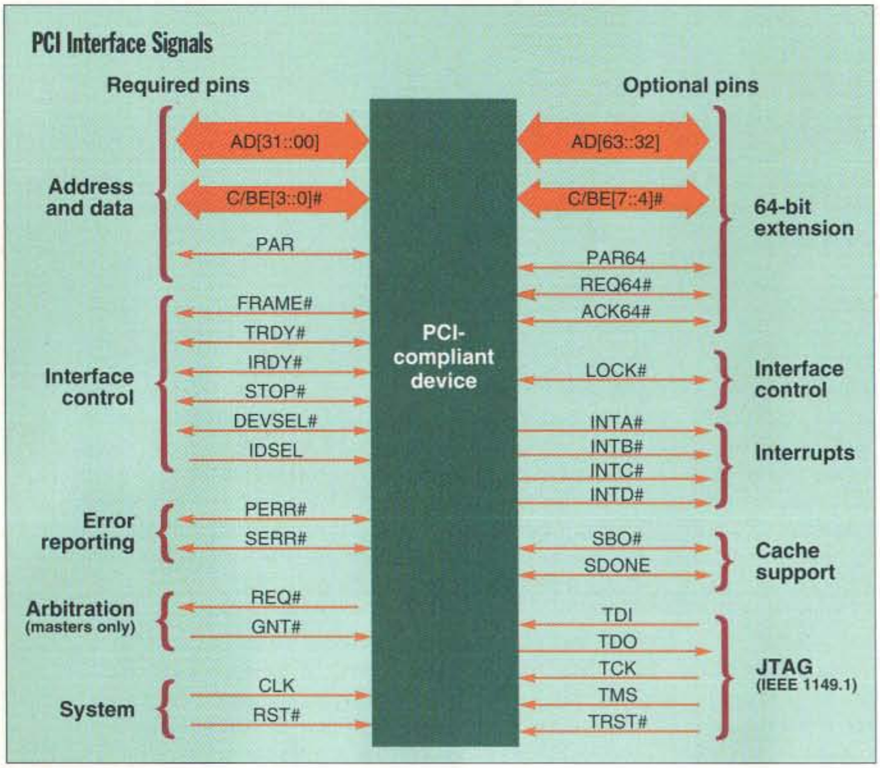


PCI pins and signals. *The required pins are signals that are needed to implement a PCI bus. The optional pins help implement a 64-bit bus, exclusive memory access (the LOCK signal), and cache support.*

bridge chip that connects the PCI bus to the processor's local bus. PCI peripherals are then connected directly to the PCI bus. Once a host bridge chip is available, a new processor has access to all available PCI components. This allows the PCI bus standard to be processor independent.

When a new processor becomes available, only the PCI-to-host bridge chip needs to be replaced; the rest of the system remains unchanged. PCI is a component- and board-level bus; other I/O buses, such as a SCSI bus, can be included in a PCI system with a controller chip or a board that interfaces to the PCI bus. Designers of I/O components such as graphics, SCSI, or LAN controllers can now concentrate on improving the performance of their products instead of continually redesigning their products for different processor speeds and bus types.

Although processors are quickly moving past 33-MHz operation, the PCI bus is defined to operate only up to 33 MHz. The processor speed can be faster than the PCI bus speed, however, because the host-to-PCI bridge isolates the processor bus from the PCI bus. The bridge chip can contain buffering to enhance performance and bus utilization. This is especially useful when using a processor, such as the 486, that doesn't support burst writes. Since the PCI bus does support burst writes, the host bridge can buffer a nonburst write from the processor and present it to the PCI bus as a burst write. A bridge might contain other system-support logic, such as for a cache controller or for handling the PCI bus's centralized arbitration mechanism.

PCI won't replace the standard expansion buses that are popular today, but instead it will complement them. These expansion buses are added to a PCI system by the inclusion of a PCI–to–expansion bus bridge chip. The standard expansion buses (e.g., ISA, EISA, Micro Channel, and NuBus) are lower in performance, but they provide for maximum system expandability for less-demanding peripherals.

PCI Bus Design

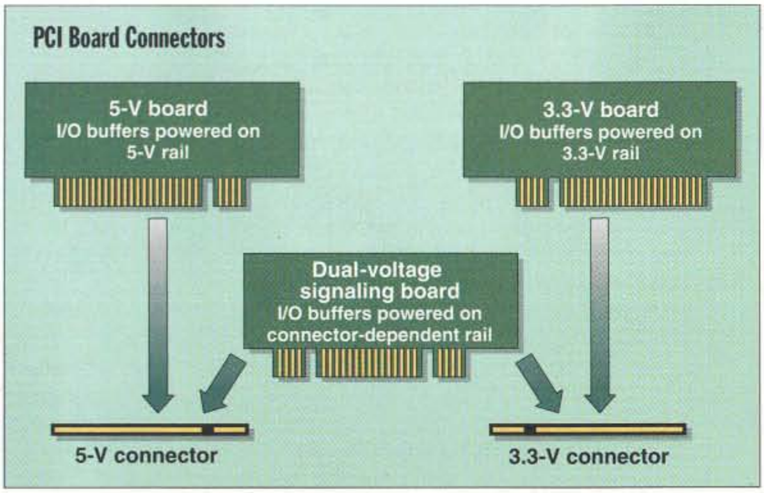
The design goals of the PCI bus standard were threefold. First, it would produce a low-cost, high-performance local-bus interface. Second, it would provide automatic configuration of components and add-in boards. Finally, the design would have the versatility to support future generations of peripherals.

The cost and size of connectors, chips, and motherboard traces increase as the number of pins needed to implement a bus increases. The PCI standard reduces costs by using a multiplexed address and data bus that reduces the pin count and size of the components. A PCI target (which is defined later) can be implemented with only 47 pins, and a PCI master can be implemented with only 49 pins.

Despite the small number of lines, this setup can manage bus addressing, data transfer, arbitration logic, and interface control.

The figure "PCI Interface Signals" lists the PCI bus pins, with both the required and optional pins shown. Note that the optional pins provide support for a cache and atomic operations. Other optional pins implement a 64-bit bus, giving the PCI standard a growth path for future systems.

Two sizes of add-in boards are specified: a standard length (about 12 inches long) and a short length (about 7 inches long). Note that the PCI bus is limited to 10 loads. Chips on the motherboard take up one load each, and add-in boards in PCI slots consume two loads each. For example, if devices on the motherboard consume four loads, this leaves six loads available, allowing three PCI slots. Too much loading can cause signals to


PCI Board Connectors
5-V board
I/O buffers powered on 5-V rail
3.3-V board
I/O buffers powered on 3.3-V rail
Dual-voltage signaling board
I/O buffers powered on connector-dependent rail
5-V connector
3.3-V connector

A keyed notch on the PCI *board determines what signal levels it supports. This allows an easy hardware transition from 5 V to 3.3 V.*

violate timing specifications, which leads to system failures.

To accommodate the industry's shift from 5-V signals to 3.3-V signals, PCI also defines a 3.3-V PCI specification. PCI add-in boards and slots are keyed so that 5-V boards plug only into corresponding 5-V PCI slots and 3-V boards plug only into 3-V slots. The PCI SIG is encouraging add-in board vendors to design "universal" boards that operate at both voltages and can plug into either a 5- or a 3.3-V PCI slot (see the figure "PCI Board Connectors" on page 178).

PCI defines three types of address space: memory, I/O, and configuration. Configuration space is a 256-byte area inside each PCI device that contains information about the device. Such information includes the type code, which indicates whether the device controls a mass-storage unit, a network interface, a display, or other hardware. Multifunction devices are supported, as long as there is only one physical connection to the PCI bus, such as one chip that supports both SCSI and Ethernet. The configuration space also contains the PCI control, status, and latency timer registers; the location of the device's expansion ROM; and the base-address registers. At power-up, the system scans the configuration space of all devices on the PCI bus and then assigns each device a unique base address and an interrupt level.

PCI BUS COMMAND CODES

C/BE[3::0]#	COMMAND TYPE
0000	Interrupt acknowledge
0001	Special cycle
0010	I/O read
0011	I/O write
0100	Reserved
0101	Reserved
0110	Memory read
0111	Memory write
1000	Reserved
1001	Reserved
1010	Configuration read
1011	Configuration write
1100	Multiple memory read
1101	Dual-address cycle
1110	Memory-read line
1111	Memory write and invalidate

A PCI device's expansion ROM contains code to initialize the device, or devices. The ROM's contents are arranged in little-endian (i.e., Intel) format, but there's nothing in the design to prohibit other processors from making use of the information. The ROM can contain different code images that initialize the device for different processor architectures. PCI provides true plug-and-play; the system takes care of hardware configuration automatically. A user just plugs in a board, and it works.

PCI Bus Operation

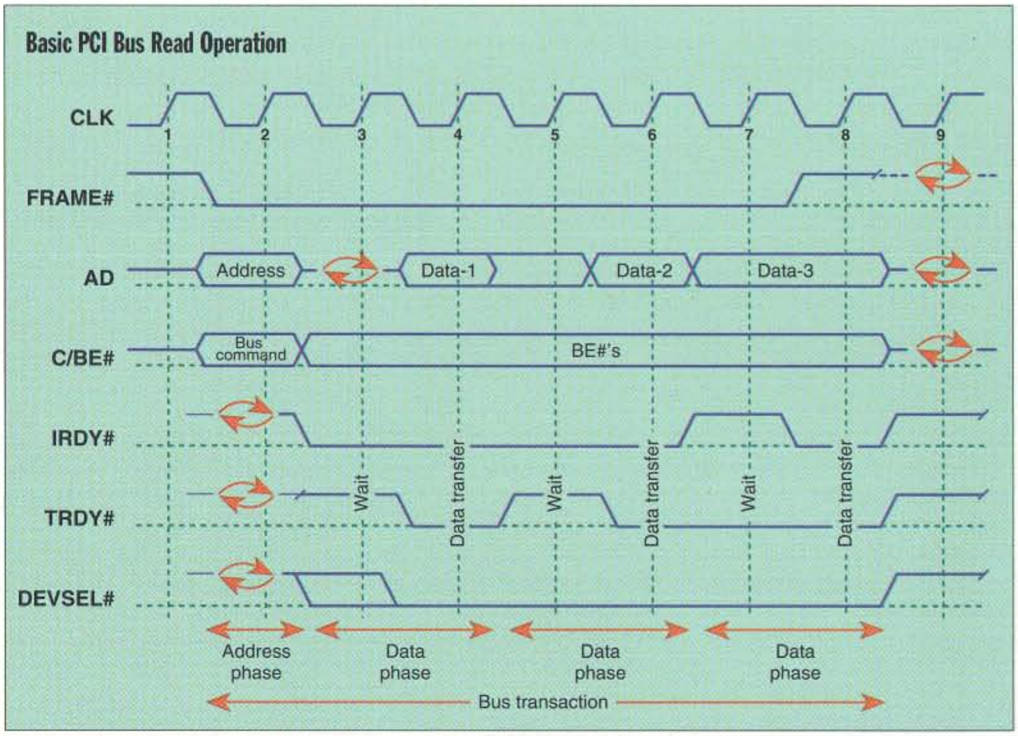
A PCI transaction takes place between a master and a target. *Master* is a term used by the PCI standard for a bus master (i.e., a device that takes control of the bus and initiates accesses, such as a processor or a bus-mastering SCSI controller). *Target* is a term for a slave device (i.e., a device that only responds to accesses, such as memory or a VGA controller).

The PCI bus does all transfers as burst reads and writes to optimize performance. A normal bus access requires a new address before each data transfer, whereas a burst transfer starts with one address and then performs multiple data transfers to or from consecutive address locations. For PCI, a burst transfer begins with an address phase, followed by one or more data phases. This allows one data transfer to be performed during each clock period. This gives a 33-MHz PCI bus a burst transfer rate of 132 MBps on a 32-bit bus and 264 MBps on a 64-bit bus. Bursts can be either to the memory or to the I/O space.

PCI burst transfers have an indefinite length, whereas most other architectures have a limited, fixed burst length. PCI bursts continue until the master or target requests the transfer to end or until a higher-priority device needs to use the bus. Each PCI device has a latency timer that defines the longest period of time that that device is allowed to use the PCI bus. This timer is accessed through the configuration space and is programmed by the processor. The processor can optimize overall system performance by intelligently programming the latency timers of all devices on the PCI bus.

The master specifies the type of burst transaction by using bus commands. These commands are issued by driving the command/byte enable (`C/BE[3::0]#`) lines during the address phase of a burst. The table "PCI Bus Command Codes" shows each command's encoding and type. During the data phases, the `C/BE[3::0]#` lines carry byte-enable information that indicates which byte lanes on the bus carry data. The figure "Basic PCI Bus Read Op-

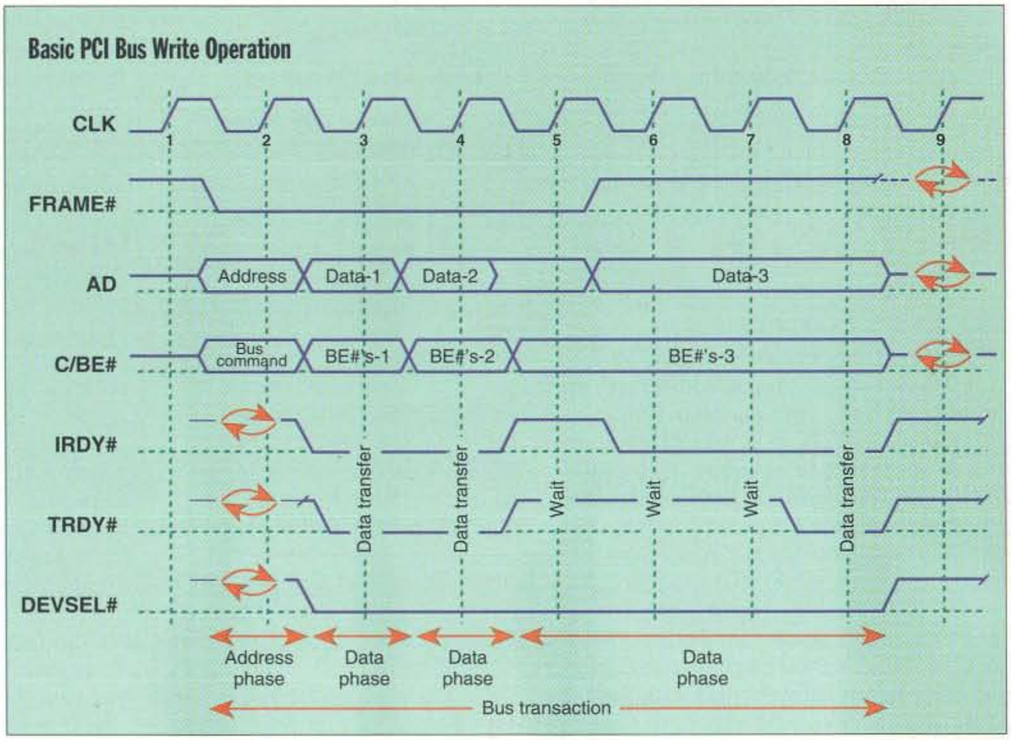
Basic PCI Bus Read Operation



A read transaction starts with the address phase, *with FRAME# asserted, AD[31::0] driving the address onto the bus, and C/BE# containing a valid PCI bus command. The data phase follows, which can have any number of data transfer and wait cycles. During the data phase, C/BE# indicates what byte lanes are used.*

eration" gives details on a PCI burst read; the figure "Basic PCI Bus Write Operation" gives details on a burst write.

Another way to improve the performance of any bus running at a particular speed is to reduce its *overhead*, which is time that the bus is in use but data is not being transferred. When a PCI device wants to access the PCI bus, it must request use of the bus from the central arbiter (which can be located in the PCI-to-host chip) by using its REQ (request) signal. The arbiter uses its GNT (grant) signal to allow the device to use the bus. On most buses in use today, the arbitration process takes up cycles that could be spent transferring data. PCI eliminates this loss by allowing the arbitration for the next access to occur while the current access is still in progress.


Basic PCI Bus Write Operation

A PCI write transaction is similar *to a read transaction. The data phase of read and write transactions ends when both IRDY# and TRDY# are asserted. The wait states shown here are inserted only when a slow device is accessed.*

The PCI bus can transfer data 32 bits or 64 bits at a time. The optional signals REQ64 and ACK64 allow a 64-bit master to ask if a target is capable of 64-bit data transfers. A 64-bit transfer occurs only if a master asks for a 64-bit transfer and a target responds that it can do such transfers.

A PCI master can support 32- or 64-bit addressing regardless of whether it supports a 32- or a 64-bit data path. Since a master might not be able to look at a target's configuration space, a master that supports 64-bit addressing doesn't always know if a target supports 32- or 64-bit addressing. Therefore, the master must be able to present an address in a format that either type of target can accept. The master addresses 32- or 64-bit devices capable of 64-bit addressing by issuing a dual-address-cycle command.

To implement such a command, during the first address cycle the master first drives the lower 32 bits of the 64-bit address on the lower 32 bits of the bus, and the upper 32 bits of the 64-bit address on the upper 32 bits of the bus. During the second address cycle, the upper 32 bits of the 64-bit address are driven again, but this time on the lower 32 bits of the bus.

A 64-bit target will take in the full 64 bits of the address on the first clock cycle, ignore the second address phase, and decode the 64-bit address with no additional delay. A 32-bit target must wait an additional clock cycle to receive the full 64-bit address, since it is transferred in two 32-bit portions. Targets that support only 32-bit addressing are mapped into the lower 32 bits (4 GB) of address space, so they can be accessed by masters that support 32- or 64-bit addressing transparently.

PCI's Future

In the past, many interfaces were designed with only current rather than future needs in mind. PCI was designed to meet the needs of today's systems while leaving plenty of room for growth. The PCI local-bus architecture provides the bandwidth required to accommodate the demands of today's high-performance operating systems. This interface is finding its way into everything from portables to high-end file servers and workstations.

Currently, a PCI motherboard requires multiple components—in addition to the processor—to implement PCI. This consumes valuable space on the motherboard and increases cost. However, since it is a widely accepted standard, PCI components from a variety of sources and with different levels of integration should bring down the size and cost of a PCI system.

Also, DEC's DECchip 210066 RISC processor foreshadows an important trend: It implements a built-in PCI bus interface. Processors using a built-in PCI bus interface are especially attractive for users of portable computers that don't have the space for multiple components, and it will drive down the cost of all PCI systems because of the greater level of integration.

PCI offers different advantages to different segments of the computer industry. To PC designers, PCI offers outstanding performance and a plug-and-play mechanism through a new system architecture. To workstation designers whose systems already have buses faster than PCI, it offers access to the low-cost, industry-standard components used in PCs. To everyone, it provides a way to resolve many of the historical problems the industry has had by providing a well-thought-out architecture that will propel us into the next decade of computing. ■

Editor's note: *To obtain a copy of revision 2.0 of the PCI specification or to join the PCI SIG, contact the PCI Special Interest Group, M/S HF3-15A, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124, (503) 696-2000; fax (503) 693-0920.*

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Windows for Workgroups 3.11

Previews of two new technologies—Chicago and At Work—make this the most advanced version of DOS-based Windows now available

JON UDELL

I've long thought Windows for Workgroups a vastly underrated product. The original version (3.1), dubbed Windows for Warehouses, languished in part because the MIS crowd saw its peer-networking capabilities as a security risk. That view seemed shortsighted to me. Peer file sharing was always an optional feature of WFW. Subtract that, and WFW would still be an extremely useful complement to a server-based LAN. Mail, group scheduling, Clipboard sharing, and network DDE are powerful enhancements to the basic NetWare file and print services. Thanks to WFW's dual-shell capability, a Windows workgroup enjoying these extra services can coexist comfortably with a preexisting NetWare LAN.

WFW 3.11 improves on the original version in ways that preview two new technologies that are strategic for Microsoft. Its new 32-bit file and network I/O move toward the protected-mode device-driver model we'll see in Windows 4.0 (aka Chicago). And version 3.11's fax software plays into the smart-office initiative known as At Work.

What about those MIS security concerns? Version 3.11 enables an administrator to control file, print, and Clipboard sharing. An encrypted file stored locally on each WFW 3.11 machine selectively enables or disables these features. An administrator can force the security settings stored in that file to synchronize, at start-up, with canonical settings stored on the network. With version 3.11, an administrator can also choose to reform version 3.1's troubling habit of caching passwords, arguably its worst security flaw.

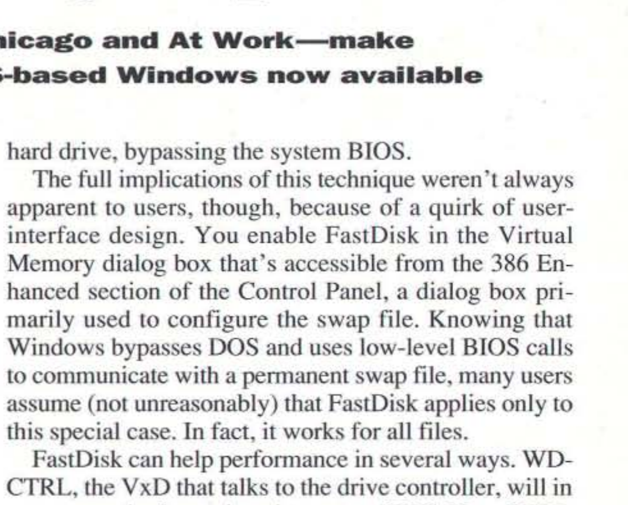
On the Road to Chicago

The big story isn't security, however. New 32-bit file and network I/O technologies put WFW 3.11 a half-generation ahead of any current DOS-based version of Windows—and within shouting distance of Chicago. Like many newfangled Windows features nowadays, these are implemented as VxDs (virtual device drivers) that run in a true 32-bit environment unavailable to normal Windows applications.

Most Windows users got their first taste of 32-bit device support in the form of FastDisk, the protected-mode BIOS interceptor that debuted in Windows 3.1. On machines with WD1003-compatible (or older ST506) drive controllers—this covers most Windows machines, including the majority now sold with IDE controllers—Windows 3.1 can hook INT 13h and talk directly to the hard drive, bypassing the system BIOS.

The full implications of this technique weren't always apparent to users, though, because of a quirk of user-interface design. You enable FastDisk in the Virtual Memory dialog box that's accessible from the 386 Enhanced section of the Control Panel, a dialog box primarily used to configure the swap file. Knowing that Windows bypasses DOS and uses low-level BIOS calls to communicate with a permanent swap file, many users assume (not unreasonably) that FastDisk applies only to this special case. In fact, it works for all files.

FastDisk can help performance in several ways. WDCTRL, the VxD that talks to the drive controller, will in many cases be faster than the system BIOS. Use of WDCTRL eliminates one costly switch between protected mode and real mode. And WDCTRL can sometimes handle I/O asynchronously, letting Windows do other work while a request completes.



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Sending DOS to the Sidelines

With FastDisk intercepting the BIOS, the bottleneck is DOS itself. Under Windows 3.1, it's still necessary to switch from protected mode to real mode so that DOS can look up the location of a requested piece of a file in the FAT (file allocation table) and then back to protected mode, where WDCTRL can field the resulting INT 13h call.

Why not take DOS out of the loop as well? That's what WFW 3.11's 32-bit file access feature does, using a pair of new VxDs. VFAT.386 delivers protected-mode

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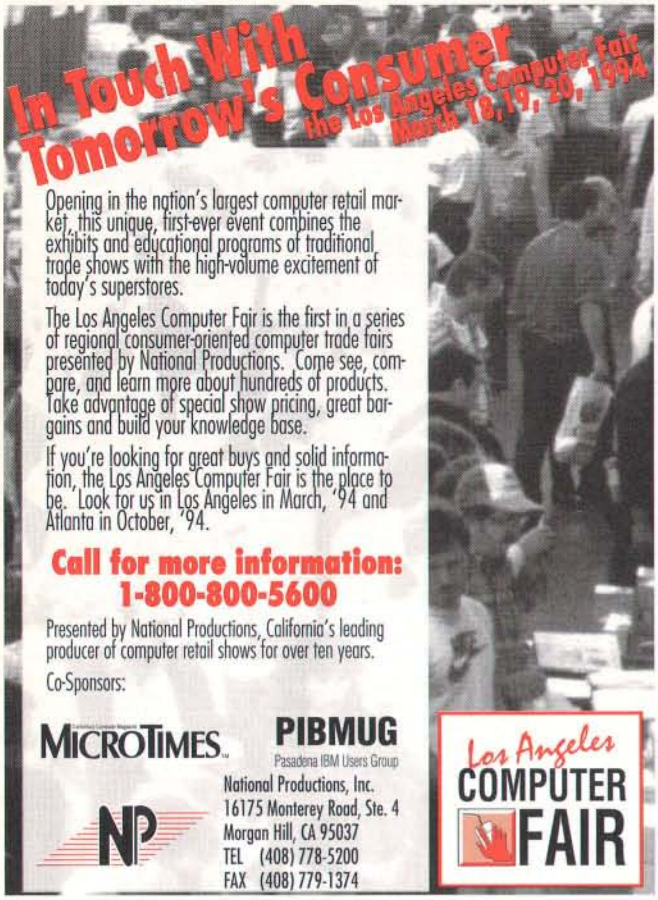

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INT 21h services, and VCACHE.386 is a protected-mode replacement for the SmartDrive disk cache. As with FastDisk, and still a bit confusingly, you enable this 32-bit feature (per drive) by way of the Virtual Memory dialog box.

The results can be impressive. An Advanced Logic Research Flyer 32LCT 4DX2/66 with an IDE controller more than doubled its sequential file I/O throughput using the VFAT/VCACHE combo, while bettering its random file I/O throughput by about a third. But on an Everex Step 486DX2/50 with an Adaptec AHA-1742 controller, and an IBM PS/2 Model 90 XP 486 with an IBM SCSI-2 controller, the story was quite different. Here, random file I/O throughput improved by 73 percent and 83 percent, respectively. These marks were close to (for the Everex) or better than (for the PS/2) those posted by Windows NT on the same two machines. But in both cases, 32-bit file access hurt sequential file I/O performance. The PS/2 lost a fifth of its 16-bit throughput; the Everex lost a fourth. This degradation made application load times noticeably slower on the two SCSI machines.

As you've probably now realized, VFAT and VCACHE don't require FastDisk—although they do prefer it. That's fortunate, because controller manufacturers didn't support FastDisk as unanimously as Microsoft hoped they would. Some companies, including Ultrastor and Future Domain, offer FastDisk drivers for their SCSI controllers; others, notably Adaptec, do not.

You should note, therefore, that VFAT and VCACHE seem to perform rather differently on FastDisk and non-FastDisk systems. If you can use FastDisk, 32-bit file access seems like a clear winner. But if you can't, don't assume it will boost throughput in all cases. You should probably test your bread-and-butter applications with and without VFAT/VCACHE to determine whether they help or hinder.

You should also know that while VCACHE unifies caching for local hard drives (VFAT) and remote ones (VREDIR), it won't cache floppy or CD-ROM drives. To cache these, you'll still want to use the provided SmartDrive 5.0 (which also comes with MS-DOS 6.2).

32-bit Networking

The 32-bit networking components of version 3.1 included the NetBEUI transport, the NetBIOS interface, the server, and the redirector. Version 3.11 adds 32-bit (NDIS 3.0) adapter drivers and a 32-bit SPX/IPX protocol stack with a Novell-compatible NetBIOS. A 32-bit TCP/IP stack is in the works, too, but unfortunately it didn't ship with version 3.11.

Using NetDDE to ship a 50-KB chunk of data between two stations, I found the 32-bit network-card NE2000 and SMC drivers to be 25 percent faster than their 16-bit counterparts. As with the 32-bit disk and file technology, the dominant effect is almost certainly the reduction in protected-to-real-mode switching.

Configuring for the test, however, proved more challenging than I'd have thought. For a given protocol, WFW 3.11 offers four driver options: Novell's ODI (Open Data-Link Interface), real-mode NDIS, real- and protected-mode NDIS, and protected-mode NDIS. You use the ODI option for NetWare connectivity or if your adapter lacks bundled NDIS support. With ODI, you can access network hardware in real mode only. The NetWare shell, of course, runs in real mode, too, but you can still layer on that foundation either or both of the 32-bit transports (i.e., NetBEUI and SPX/IPX) for use by the Windows networking components.

Real-mode NDIS, like ODI, puts 16-bit adapter support underneath 32-bit transports. The real-and-protected option, confusingly, installs 16- and 32-bit adapter support; Windows uses

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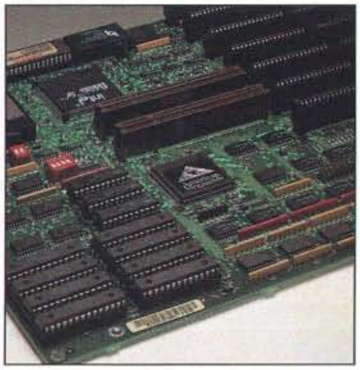

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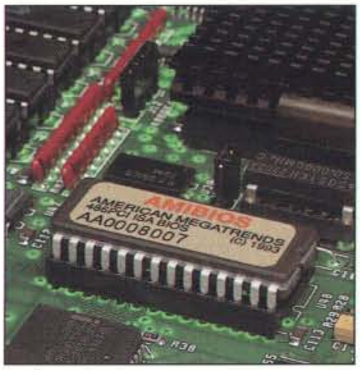

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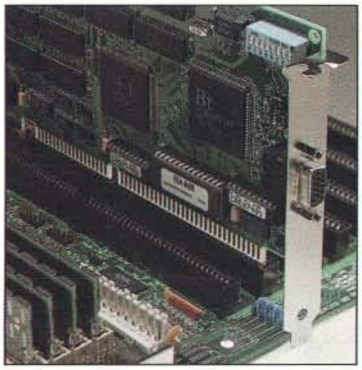

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the 32-bit code, but the 16-bit code is available for use in DOS. Finally, protected-mode NDIS installs and uses only the 32-bit NDIS 3.0 driver.

To make things even more interesting, WFW 3.11 installs both NetBEUI and SPX/IPX transports on top of whichever flavor of driver you choose and makes SPX/IPX the "default" protocol. The availability of a routable protocol, namely SPX/IPX, is a great thing. As I discussed last month, you can dispense entirely with NetBEUI in this version of Windows for Workgroups and run file, printer, and Clipboard sharing solely on SPX/IPX.

If you happen to operate a NetWare WAN (wide-area network), this arrangement WAN-enables Windows networking in a way that was never before possible. But I ran into problems using the SPX/IPX stack (and its companion NetBIOS) with WFW's NetDDE. When SPX/IPX was the default protocol, Clipboard sharing and other light-duty NetDDE operations worked, but the 50-KB transfer I used to measure over-the-wire performance failed.

The same transfer worked flawlessly when I used NetBEUI as the default transport. So while my NetDDE test didn't satisfy my curiosity as to whether NetBEUI or SPX/IPX is the faster 32-bit transport, it did raise concerns about the suitability of SPX/IPX as the preferred transport for Windows networking.

The Fax Connection

The Chicago technology in WFW 3.11 is tantalizing, if a bit rough around the edges. Microsoft's At Work technology that debuts in version 3.11 is equally tantalizing and, while limited in scope, quite successful. At Work is an umbrella standard that Microsoft hopes will enable PCs, telephones, printers, copiers, and fax machines to cooperate intelligently on a network.

A compliant fax machine, for example, will run the At Work operating system (a 16-bit real-time preemptive multitasker) and will present a touchscreen user interface based on a subset Windows API. (Prototypes of these smart fax machines were shown at last fall's Comdex.) A pair of fax devices will be able to exchange not only conventional faxes, but also compact binary attachments that survive as editable documents.

How does this differ from E-mail? It doesn't, really. For PC Fax, the At Work–compliant fax-server software in WFW 3.11, fax *is* E-mail. A sender need actually render an image of a document only when the receiver indicates it cannot receive a more compact and infinitely more useful binary transfer.

The current limitation is that there aren't any At Work devices other than WFW 3.11 PCs. Thus, for most users in the near future, PC Fax will operate as a conventional fax server. In that capacity, however, it excels. Outbound and inbound faxing on one WFW machine with an attached SupraFaxModem was trivial, as was sharing that modem from another WFW machine. Because PC Fax is implemented as a form of E-mail, you can broadcast to a mixture of E-mail and fax destinations using a single distribution list. Equally important for integrators, you can send faxes programmatically using simple MAPI (Messaging API).

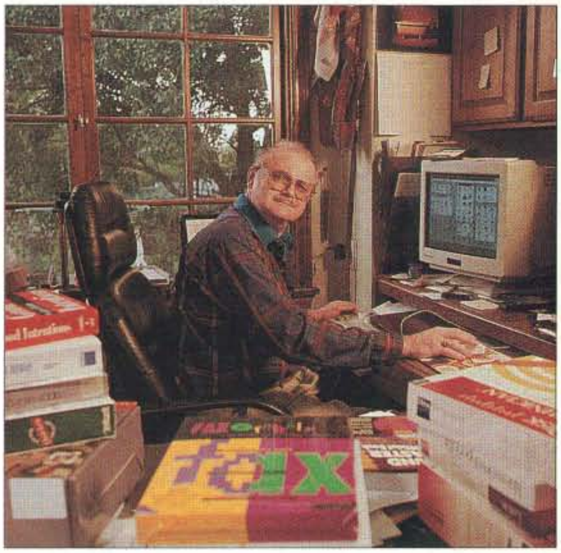
Announced last June, At Work has now begun to emerge from shrouds of vapor. It's a grab bag of rendering, communications, and real-time operating-system technologies, none of which is by itself earthshaking. But if vendors buy into this vision of smart networked office equipment, At Work could do more for millions of workers than any version of Windows. ■

Jon Udell is a BYTE technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.

JERRY POURNELLE

Upgrades from Hell

Installing CD-ROM drives and graphics accelerator cards turns into pitched battles between Jerry and the Chaos Manor computers



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I've been told that my best columns happen when I've had a whole lot of problems. That ought to make this one a doozy. I've been tearing my hair out for a week. All's more or less well now, but I sure have a lot to tell you.

It all started when I asked Alex to install ATI Technologies' CD Sound Dimension Multimedia Upgrade Kit in SuperCow, our Gateway 2000 486DX2 with local-bus video. It's fast and reliable. It sits on a computer cart, making it nearly ideal as a test-bed for new equipment. Alex installed the full-length sound and CD-ROM controller board, but he noted there were no mounting rails for the CD-ROM drive, so he didn't unpack that. He did get the sound board working, and pretty soon Chaos Manor was filled with the sounds of Captain Kirk, Dr. McCoy, and Mr. Spock, generated by Berkeley Systems' After Dark screen saver, and a screwy program called Icon Hear It.

I have reports from sound experts that the ATI sound board is not quite 100 percent compatible with Sound Blaster Pro, but it has played all the sounds, including games, that we've tried with it, and we've had no problems. I can suggest one improvement. The board has an option to connect the sound output of your system to the board, where you have volume control, but to do that you must disconnect the internal speaker, which means that you must have an external speaker connected to the board or you'll get no sound at all. I wish they'd set it up so the internal speaker is activated when you unplug the external speakers. Other than that, the ATI board is quite acceptable, and it's easy to set up.

Mind you, no sound board has as good quality for the money as Turtle Beach Systems' MultiSound. Unfortunately, it's for Windows only, and it won't play the sounds used by just about all the game designers. If you're serious about sound, get the MultiSound. Incidentally, it will coexist quite nicely with the ATI board or Sound Blaster Pro, but you have to be a real sound fanatic to go that route.

The ATI CD-ROM drive didn't need any mounting rails. When I unpacked the Mitsumi-labeled Matsushita drive, I found it comes in a little metal cage that replaces mounting rails; it makes a snug fit, but it's easy to install in the half-height bay that's below SuperCow's floppy drives. I like the drive design a lot: you press on the drive face and the whole thing slides out. Open a lid on top and drop in your CD; no caddy needed. I've always had mixed emotions about those caddies. If CD-ROMs came in them, it would be different; but no, CD-ROMs are shipped in jewel boxes, and you have to provide the caddies yourself. I have never been able to open a caddy without a fight. Anyway, the ATI system doesn't use them.

There's only one way the CD cable will attach to the drive, so that was no problem. Alas, it's quite possible to attach the cable the wrong way to the sound board. Fortunately, the installation diagrams show where pins 1 and 2 are on both drive and board, and once I noticed that, all was well.

The software installation is pretty simple, but I found one subtle problem, which I'll explain in just a minute. There's a place to set the start-up

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configuration, and Alex had set the CD-ROM drive to disable. Enabling it is easy enough, but when you do, the board can't find that CD-ROM drive until you power down and turn the machine back on. Meanwhile, you can set the interrupt channel (i.e., IRQ [interrupt request] number) and I/O port addresses for the CD-ROM drive. That's all explained quite well in the ATI manuals, but the screen setup is simple enough that you probably won't look into the manual at all.

> **I was awakened at 0700 by the telephone. It was a flack from the Dithering and Redundancy Corporation.**

I set things up, powered down, noted that the CD-ROM light flashed when the machine powered up, and tried to access the CD-ROM drive. "Drive not ready." I reset the machine and tried again. Same thing. Time for some logic.

First thing, eliminate any distractions. SuperCow had the Maximum Storage Duette optical drive running off a Future Domain SCSI board; eliminate that and comment out the software device installations in CONFIG.SYS. Reset. Still no joy.

Next, cables: I disconnected the cable from the ATI board, liberally spread on Stabilant 22 (a connection enhancer), and connected again. Reset. This time it worked. Now enter Windows for Workgroups 3.11, go to File Manager, and access the CD-ROM drive. The system locked up to hardware reset.

Clearly some kind of conflict, probably in the interrupt processing: each of these devices must be assigned a unique IRQ number. The sound board was set to IRQ 7. There were several possibilities for the CD-ROM drive, but the default was IRQ 5, and I saw no reason to change it. Now to look at the network board. That's an Intel EtherExpress, and it's examined and set with a simple-to-use Intel program called SoftSet. SoftSet told me that, sure enough, the network board was set to use IRQ 5, the same as the ATI board was using for the CD-ROM drive.

The subtle bug I mentioned earlier is that the ATI software will warn you if you try to *change* to an interrupt line that's already in use, but it doesn't notice if the default IRQ creates a conflict when you first activate the board. Anyway, I told SoftSet to change EtherExpress to use IRQ 10. Then I did extensive tests of the CD-ROM drive under DOS. No problem, so bring up Windows for Workgroups. The system again locked up to hardware reset.

Maybe, I thought, I needed to power down the system after changing the EtherExpress settings. I tried that, made sure I could get the directory on the CD-ROM drive, and brought up Windows for Workgroups again. That came up fine. Go to File Manager and try to access the CD-ROM drive. System locks up.

By then it was quite late at night. I reset, noted that I could get a CD-ROM directory when in DOS, left the machine logged to the CD-ROM drive, fired off an angry fax to ATI Technologies' technical-support staff, and went to bed.

I was awakened at 0700 by the telephone. A flack representing the Dithering and Redundancy Corporation had got my telephone number and called to find out if I'd received their product. When I pointed out that it was 0700, she was apologetic. "I didn't know it was your home number," she said.

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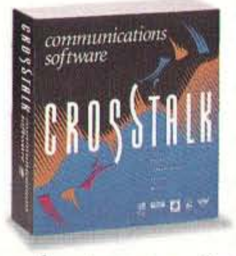

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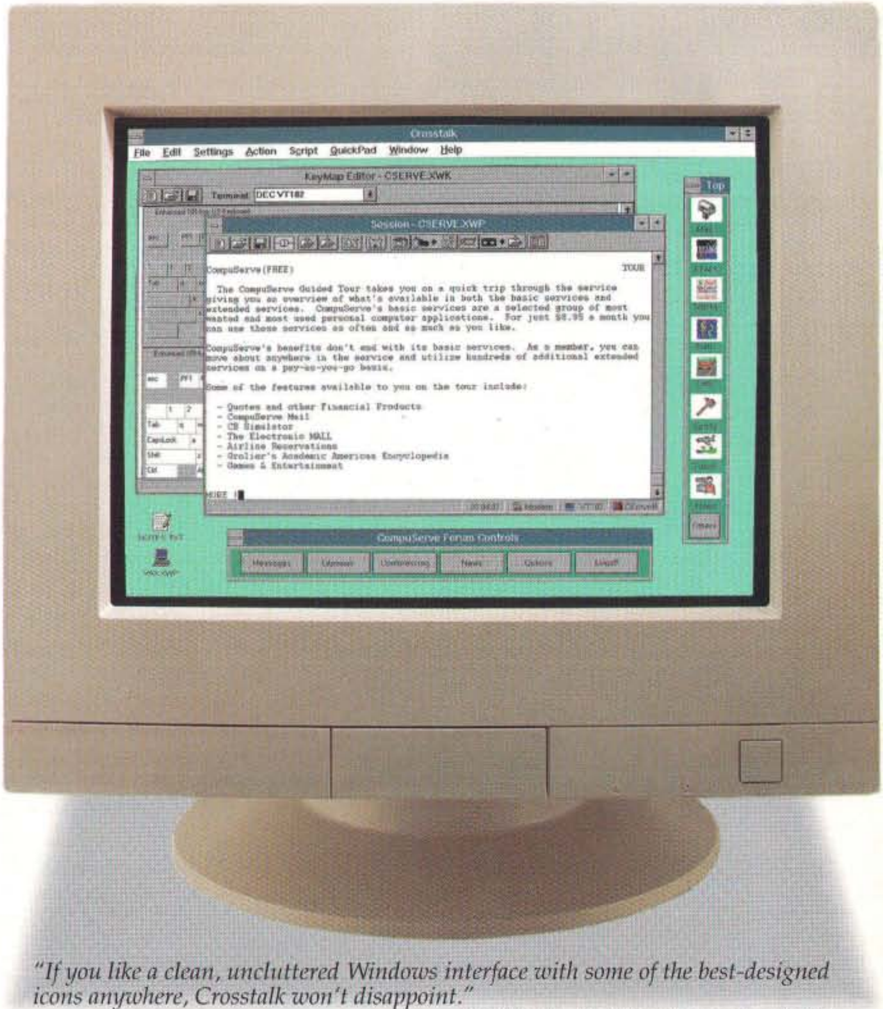

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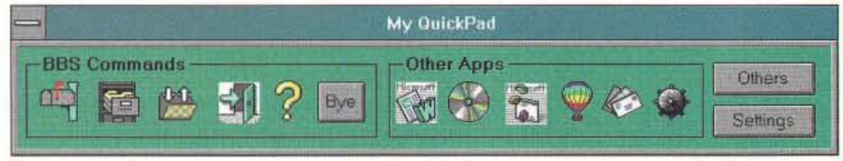

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I may have been unduly harsh—I don't guarantee that I'll be either civil or coherent at 0700 after fighting an installation problem all night—but someone in her firm ought to have had better sense. I sometimes suspect these PR flacks get paid by the "contacts" they make, even though few of their messages warrant the urgency of a telephone call. Anyway, that's how the day started.

The evil daemon inside Windows for Workgroups 3.11 will reset your network board interrupt without checking for clashes—and without telling you what it did.

Rick Osborne of ATI Technologies' technical-support staff called about 10:00 a.m. I hauled the phone over to SuperCow. It was still running, but it would no longer access the CD-ROM drive. That was suspicious. I reset the machine, logged on to the CD-ROM drive and got a directory, went into Windows for Workgroups, and locked the machine when I tried to access the CD-ROM drive. Reset. Use the ATI installation program to be sure of the settings: sound board at IRQ 7, CD-ROM drive at IRQ 5. Now use SoftSet to check the network board. It was set to IRQ 5.

I was absolutely certain I had set that to IRQ 10. I set it to IRQ 10 again. Still in DOS, I accessed the CD-ROM drive; it worked fine. Enter Windows for Workgroups. Machine locks to hardware reset. Reset. Now I can bring up Windows for Workgroups, but going to File Manager and trying to access the CD-ROM drive locks the machine. Reset. Use SoftSet—and find that EtherExpress is set to IRQ 5 again.

Something is real weird, folks. OK, use SoftSet to set EtherExpress to IRQ 10 again; and this time get out all eight floppy disks and install Windows for Workgroups again. Tediously I swapped disks. Finished. Powered down and then back up. Can't enter Windows for Workgroups. Reset. Now I can enter, but accessing the CD-ROM drive locks up the machine—and EtherExpress is set to IRQ 5.

The conclusion is clear: the evil Microsoft daemon inside Windows for Workgroups 3.11 is resetting EtherExpress, and it's doing that without telling me. The first remedy was to leave EtherExpress at IRQ 5 and change the CD-ROM drive to IRQ 10. That worked just fine, so I let Rick Osborne, who had been patiently listening as I went through all this, go back to work.

The problem is that to change the network settings for Windows for Workgroups, you have to be inside Windows. Invoking Setup in DOS lets you change video drivers, but not network card settings. However, when Alex got home, he reminded me of something I had forgotten. If you're running Windows for Workgroups, you can access Windows without the network: simply invoke it with WIN /N <return>.

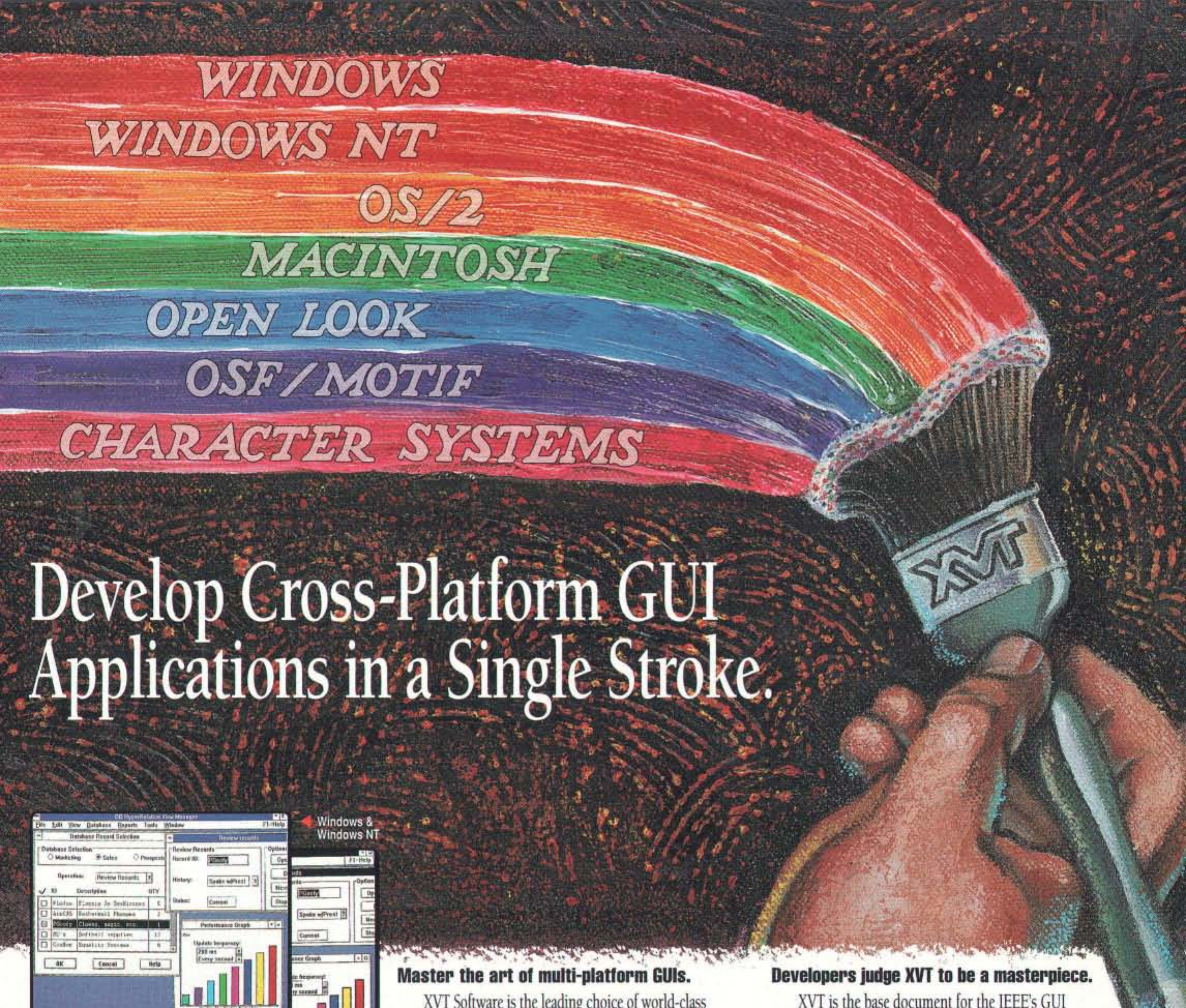
Once you're in Windows, you have available all the controls, including a new program group that Windows for Workgroups 3.11 automatically installs for you. Inside it are some neat tools that include a Network Setup icon; open that, use the drivers button to open a second window, use the setup button to pop up yet another box, and lo!, there is the EtherExpress IRQ setting.

I did all that and changed that setting to IRQ 10. Immediately I got a warning box: IRQ 10 was in use. Interesting, I thought: this part of the program is smart enough to detect interrupt clashes. I told it to use IRQ 10 anyway. Then I exited Windows and went to the ATI Setup program to set the ATI CD-ROM board from IRQ 10 back to IRQ 5. Once again I got a warning box: IRQ 5 was in use, as of course it was since I hadn't changed the network board; and once again I ignored the warning.

Then I tried to enter Windows for Workgroups again. As expected, the system locked up. Power down. Power back up. Test the CD-ROM drive in DOS. Worked perfectly. Enter Windows for Workgroups. No problem. Access the CD-ROM drive: still no problem, not then, and not later.

The conclusion is clear: the ATI software worked fine, but Windows for Workgroups will reset your network board interrupt without checking for clashes—and without telling you what it did. This is an evil bug masquerading as a feature, and we can hope that Microsoft will exorcise it as soon as possible.

As for the CD Sound Dimension Multimedia Upgrade Kit, if you can get one at a good price, you'll probably be happy with it. The ATI sound board is good enough, although in my judgment Sound Blaster Pro is better. The ATI CD-ROM



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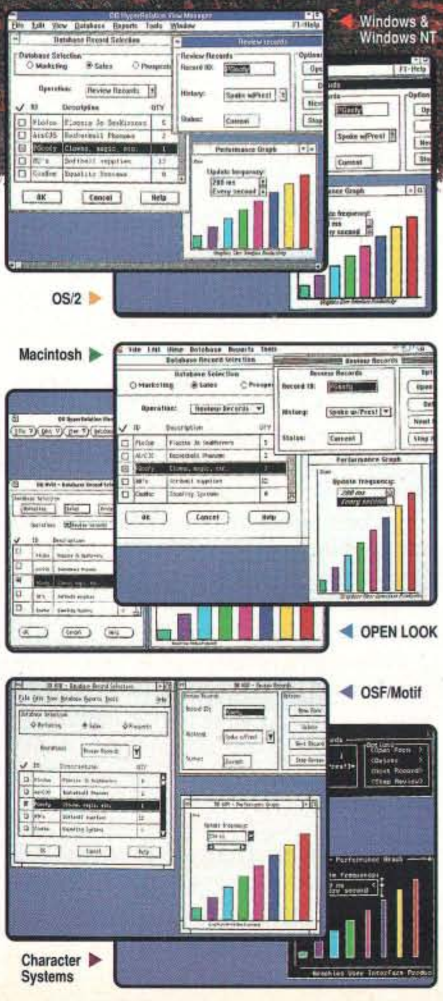

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drive is definitely better than the single-speed CD-ROM drives in Creative Labs' early multimedia kits. However, Creative Labs' new Sound Blaster multimedia kits have modern two-speed drives, too, and I'm told they have genuine SCSI rather than the proprietary almost-SCSI the original kits had; more on that next month.

ATI gives you a couple of CD-ROM discs of shareware, most of it not very interesting, nothing like the mountain of software you get with Creative Labs' multimedia upgrade.

The bottom line is that ATI's CD Sound Dimension Multimedia Upgrade Kit is easily installed and is configurable with easy-to-understand software—no jumpers to set. It gives pretty good sound, and the CD-ROM drive is fast and reliable. I'd look at the competition, but if you can get an ATI kit at a good price, go for it; it's more than good enough.

When you get your CD-ROM drive set up, use Norton Speedrive. It does a great job of speeding up a CD-ROM drive. I also recommend it over Microsoft's SmartDrive even if you don't have a CD-ROM drive, but there it's not so clear. Windows 3.1 looks at your drive controller and, if it's suitable, offers a 32-bit disk access mode. You can turn that on from the control panel. In the control panel, open the enhanced button (the one that looks like a computer chip); in that, open virtual memory and click on the change button. If you're offered the option of 32-bit disk access, take it.

Fair warning: be sure you have a good backup of your WIN.INI and SYSTEM.INI files before you do this. I don't know anyone who has got locked out using this (other than the frazzled Alex), but caution is always wise.

If you're running Windows for Workgroups and you've upgraded to version 3.11, you may be offered a second option, 32-bit file access. If you click on that, you'll also be offered the chance to specify a cache size. Mine wants 4 MB, which speeds things up but is silly; on the other hand, cutting that to 512 KB doesn't seem to speed things. I found that 1 MB gives all the improvement I'm going to get.

These 32-bit accesses work with SmartDrive, and they do speed things up. I haven't had a chance to test them with Speedrive, so I don't even know if that will work at all, much less show a speed improvement. More next month.

Once we had the CD Sound Dimension Multimedia Upgrade Kit installed in SuperCow, we played with new CD-

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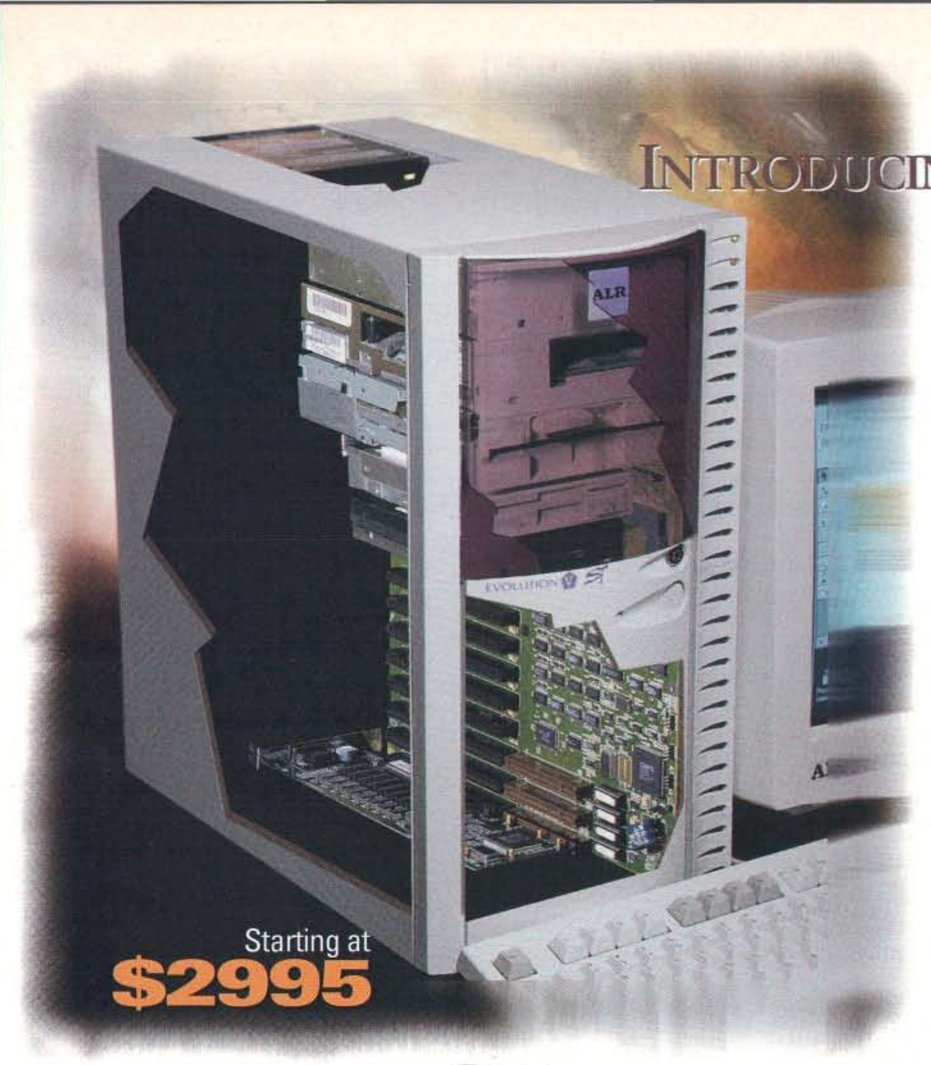
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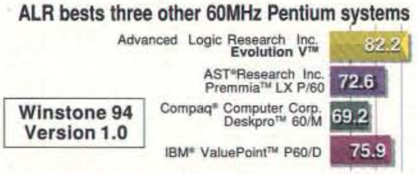

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PC Week November 1, 1993 page 21. Winstone 94 measures overall system performance, using one script for each 12 popular Windows applications. It computes the amount of time each script takes to finish, and uses those times to produce an overall score. Timed results are weighted based on the relative market share of each 12 applications.

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ROMs. The first was Microsoft Musical Instruments. The blurb on this says, "You are about to enter one of the largest music studios in the world, filled with instruments from every corner of the earth—and you can play any one you want."

That's all sort of true. From a harpsichord to five kinds of bagpipes to panpipes to a darabukka, it's all there. It's all hypertext-linked, with pictures of the instruments, their history, explanations of the various parts, sound recordings of the instrument in action—often in several ways, like jazz, classical, and rock—and the Sound Box, which lets you click on different notes and hear the result. Clicking on different notes isn't really the same as being able to play the instrument, just as seeing a picture isn't the same as being able to handle the thing.

Still, Alex and I found ourselves wasting a couple of hours fooling with this, and this CD-ROM is definitely a keeper. Any music teacher or music librarian would be thrilled to get this as a Valentine Day present.

Lately, I find that reading books on-screen gives me a headache. But if you're doing scholarly work, having the texts in electronic form for searches and comparisons is a real boon.

Another CD-ROM we looked at was the "improved" Windows version of Library of the Future, 2nd Edition. It's an improvement over the old DOS version of LOF, but it's not so much of an improvement that I'd bother to switch. It has a number of classic works. Lately, I find that reading books on-screen gives me a headache, so I don't do it much; on the other hand, some of the LOF books aren't readily available. If you're doing scholarly work, having the texts in electronic form for searches and comparisons is a real boon.

Finally, the Bureau of Electronic Publishing has a wonderful CD-ROM called Twain's World. This has everything Mark Twain wrote, biographical data, maps, historical background, sounds, and video; a Twain lover's delight. It's a lot more than just books on CD-ROM. Highly recommended.

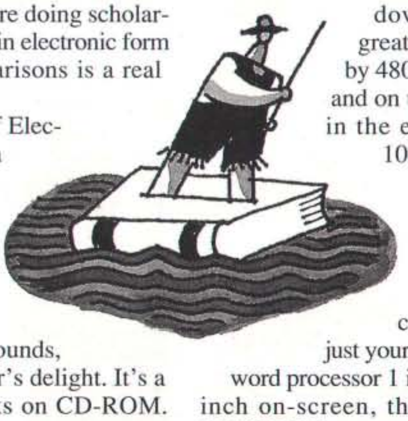
The newest machine at Chaos Manor is an AST Research Bravo LP 4/33. (The LP stands for low profile.) The machine itself is 15 inches square by 3½ inches high. I haven't had it long enough to get inside it, but I see on the back there are provisions for two slots. It also has two serial ports, a parallel port, and a mouse port. The video controller is an ATI Mach 32, and it's built in. I measure the monitor at 13 inches (they probably call it 14; I notice that monitor sizes include about half an inch of bezel on each side), and it's a good fast one capable of any screen resolution you like.

The Bravo LP 4/33 comes with MS-DOS 6 and Windows 3.1. It also comes with 4 MB of memory, which I think is a mistake. For better or worse, 4 MB just isn't enough memory for either Windows or OS/2. If, like me, you like to keep a bunch of programs open and ready to use, 8 MB is a minimum, and I prefer 16 MB.

The Bravo LP 4/33 has only one floppy drive, 3½ inches. There's no SCSI port, but several good sound cards have a genuine SCSI controller (as well as a game port), so adding tape and CD-ROM drives shouldn't be a problem. You can then use the other slot for a network board.

I like the little Bravo LP 4/33. This isn't a final report because I haven't had it long enough, but getting it did lead to more adventures.

One of the programs that impressed me at last fall's Comdex was called AnyView Screen Commander for Windows from Binar Graphics. This lets you change screen resolutions without having to restart Windows. It seemed like a great idea: jump from 640 by 480 pixels to 800 by 600 and on up, 1024 by 760, and in the extreme to 1280 by 1024, and do that as often as you like without ever having to exit and restart. It's got a bunch of other features, including a way to adjust your screen so that in your word processor 1 inch of text takes up 1 inch on-screen, thus giving you true WYSIWYG.



Since the Bravo LP 4/33 was so new that it hadn't any applications installed, it seemed like the ideal test-bed for AnyView. After all, the worst that could happen wouldn't lose me anything I couldn't replace easily.

Installation wasn't fun. First of all, the

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installation program demands your name and a company name, and you can't leave the company name blank. I solved that one by typing in "Blast your eyes" when it wanted to know what company. Then it demanded a serial number, which sent me scurrying around looking for the program's box in hopes that somewhere in that box I'd find the registration card with my serial number on it. Eventually I found it. It's a long thing, with several letters and a seven-digit number, and I assumed I'd got it right; the program never said. The installation trundled along and then reset the machine.

Alas, the Bravo LP 4/33 AUTOEXEC.BAT is set to bring the system up in Windows—and Windows was totally unusable. The cursor was a large black blob that left striped trails whenever I moved it. I couldn't even close Windows with the mouse.

This happened just after I'd spent hours on the phone over the multimedia upgrade problem, and I fear I was a little shrill when I called Binar Graphics. Their technical-support people told me there was an uninstallation program, so apparently there was going to be no problem getting things back. First, though, to get out of Windows. I punched the reset button.

Of course, their disk was in the 3½-inch drive—and there is only one drive on the Bravo LP 4/33. I got the dreaded message that this was not a boot disk. One dreads this message because it is the most common method of virus infection, and even the most reputable publishers have distributed disks with a boot sector virus. In one case I know, a disgruntled employee at the place that manufactured disks was putting a boot sector virus on every thirty-fourth disk sent out.

Meanwhile, it was time to deal with AnyView. We managed to get it uninstalled. Then I installed it again, giving it slightly different information, and this time it worked. I was able to change screen resolutions on the fly without exiting Windows.

Alas, that doesn't turn out to be quite as useful a feat as I thought it was going to be. For one thing, if you change the number of colors, you'll still have to exit Windows. For another, it turns out one rarely wants to change screen resolution. Still, it does work, and I'll try it out on other machines when I've got more time.

Now, though, I had to check the machine for a virus. The only way to do that is to boot the machine with a write-protected floppy disk that has never been exposed to a virus; and, alas, I didn't have

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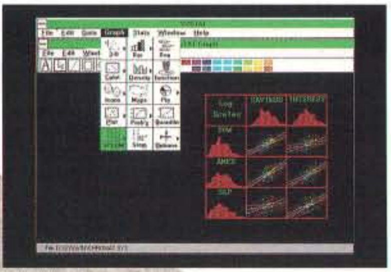

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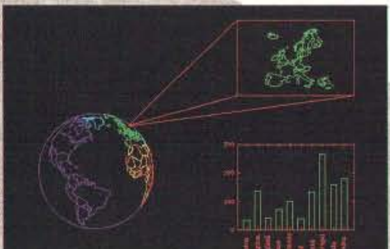

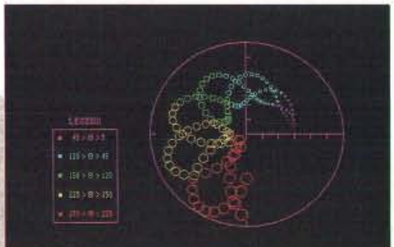

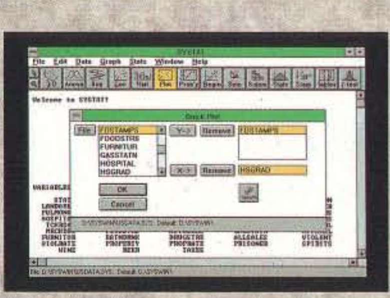

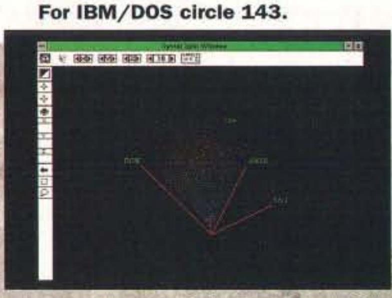

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a known-clean 3½-inch boot disk. The first thing, then, would be to make one; however, to do that, I had to boot SuperCow with a known-clean 5¼-inch disk and install the latest copy of Dr. Solomon's Anti-Virus Toolkit. It was about time I did that anyway.

Installing Dr. Solomon's is simple, and the program runs itself. Once it had checked SuperCow, I used SuperCow to make a 3½-inch boot disk. Then I tried to pry out the little door that makes a 3½-inch disk writable, but I couldn't do it, so I got some Duco Cement and glued that door open. Then I used the disk to boot the Bravo LP 4/33 and ran Dr. Solomon's. When you get Dr. Solomon's monthly updates, there are both 5¼- and 3½-inch disks, so that was no problem.

SPEEDS RELATIVE TO 486SX/20

Win Tachometer on Jerry's machines. Higher numbers are better.

	WORD PROCESSING	CAD	SPREADSHEET	PAINT	OVERALL
Bravo LP 4/33	14.64	25.9	32.4	17.61	22.64
Cheetah 486/25	13	11.92	18.43	22.52	16.47
Gateway 486/33 DX2	19.09	16.48	36.19	33.02	26.20
Cheetah 386/25	0.45	0.65	0.71	0.62	0.61
Cheetah 486/33	9.42	17.45	17.92	12.13	14.23
Cheetah 486/33	17.76	18.32	27.34	35.79	24.30
Cheetah 486/33	20.37	32.76	38.60	44.37	34.02

I hadn't expected a virus, and naturally there wasn't one; but my rule is, if you get the "this is not a system disk" message, it's time to check the machine for a virus. It's unlikely you'll find one, but it doesn't hurt to be careful.

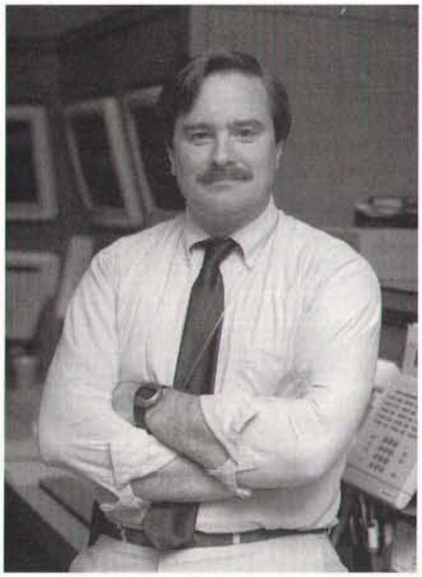
Now it was time to do some speed tests. I was eager to do that because I had just received a new copy of Texas Instruments' program Win Tachometer. This is a very neat benchmark program that simulates a number of practical applications: word processing, CAD, a spreadsheet, and a paint program. It gives you a speed estimate for each of those tasks as well as an overall speed relative to a 486SX/20 with standard VGA. This program is freeware, and it can be obtained from BBSes, including the "listings" section of the tojerry conference on BIX.

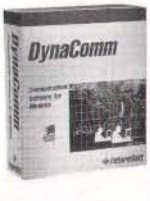
I do not like most benchmark programs. Longtime readers will recall that I once wrote one of my own. Unlike most benchmarks current back then, mine was designed to simulate doing some practical work with the computer. Win Tachometer has the same philosophy, and I like it quite a bit.

I applied it to a number of machines. The table shows the results. Note that all the systems except the Bravo LP 4/33 are running Windows for Workgroups 3.11. The Bravo is running the latest version of Windows 3.1. Both Cheetah 486s have Intel OverDrive DX2 chips, as does SuperCow. In all cases unless otherwise noted, the only open application program is Win Tachometer.

You will note there are three entries for the Cheetah 486/33, and that the first one is astonishingly slow compared to all the others, including the Cheetah 486/25. It was the value I got when I first went around testing the various machines. Needless to say, I wasn't pleased: my main machine, the one I spend my life at, is the slowest of the lot.

A puzzlement. Clearly, the 486DX2/33





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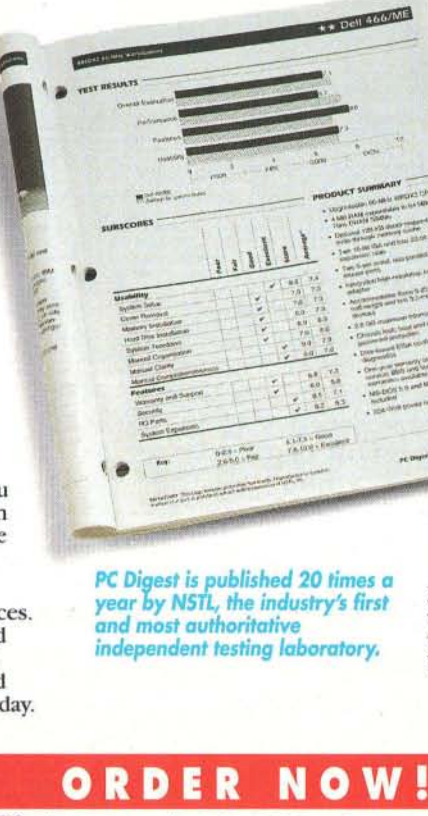

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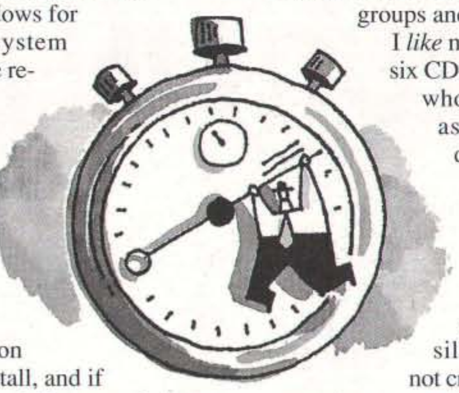
processor is as fast as SuperCow and faster than the 486/25. It wasn't likely to be the Perceptive Solutions caching controller; so it had to be the video card. On reflection that wasn't surprising. While I am quick to experiment with my other machines, I do not often make changes in Big Kat; so as improved video boards came in, they went to the other systems. Indeed, when I got out the records, I found that I was using one of the earliest ATI Technologies video accelerator boards, fully two years old (ancient in the Windows business), and the video drivers weren't much more recent. Time for a change, and fortunately I had a new ATI Technologies Graphics Ultra Pro accelerator board. I figured it wouldn't take long to install.

That didn't turn out to be the case.



I have often sworn to find and beat senseless the person who designed the IBM PC board-mounting system, and I have just renewed my vows. I have yet to change boards in a big machine without losing at least one screw down in the system and tearing the skin off one or more knuckles. Eventually I got the board in and powered up. No problems, so now it was time to install drivers.

ATI has a nifty installation program that guides you at every step, and there was no difficulty copying over and activating the Graphics Ultra Pro drivers; but when I tried to access Windows for Workgroups, the system locked up to hardware reset. This was serious, because the column was due, and this isn't a test-bed system, this is Big Kat, the machine I do all my work on. This was panicsville.

The ATI installation program has an uninstall, and if I'd been thinking I would have used that, but all I could think of was a line from the musical *Li'l Abner*: "Put 'em back, the way they was!" I took out the Graphics Ultra Pro accelerator board and put the old one back in, powered up, and while it worked just fine in DOS, I couldn't get into Windows. That forced a realization on me: while I write this column in Q&A Write, a DOS word processor, and I send it in with Procomm Plus 2.0, a DOS communications program, I would really hate it if I had to operate without Windows. Indeed, not only am I hooked on Windows, I'm hooked on Windows for Workgroups and easy networking. I *like* my system, with the six CD-ROM drives and a whole bunch of other assets available on demand.

Fortunately, there was a way to get back to where I was earlier in the day. I may do some silly things, but I'm not crazy. Before I made any changes at all to Big Kat, I did a complete backup to the Palindrome DAT (digital audiotape) drive. Restoration was a snap: I deleted the entire C:\WINDOWS directory and subdirectories, invoked Palindrome's Network Archivist, and issued the command TNARECOV.

Having said that, honesty compels a confession: it could have been that simple, but it wasn't. Instead, I fooled around

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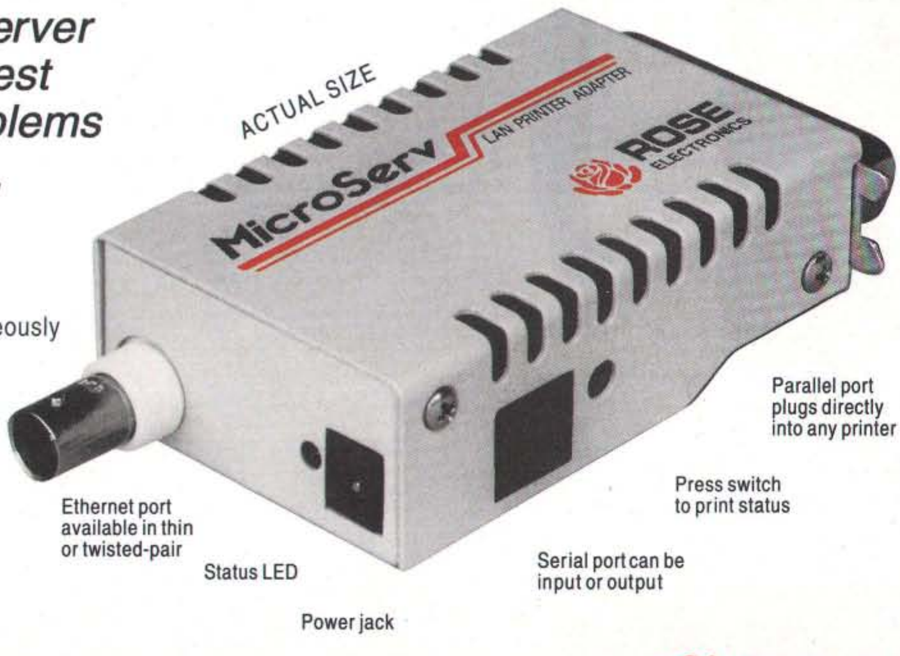
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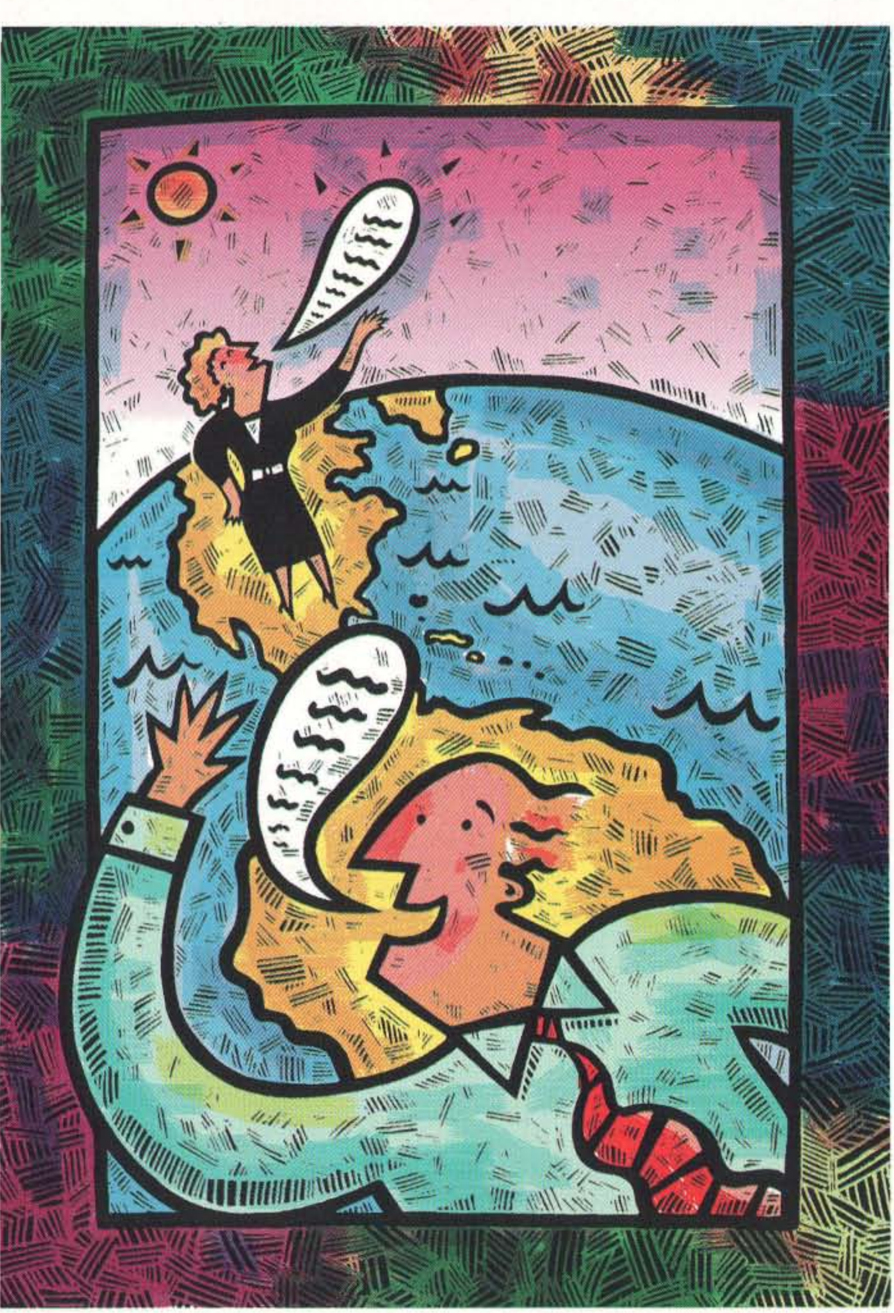

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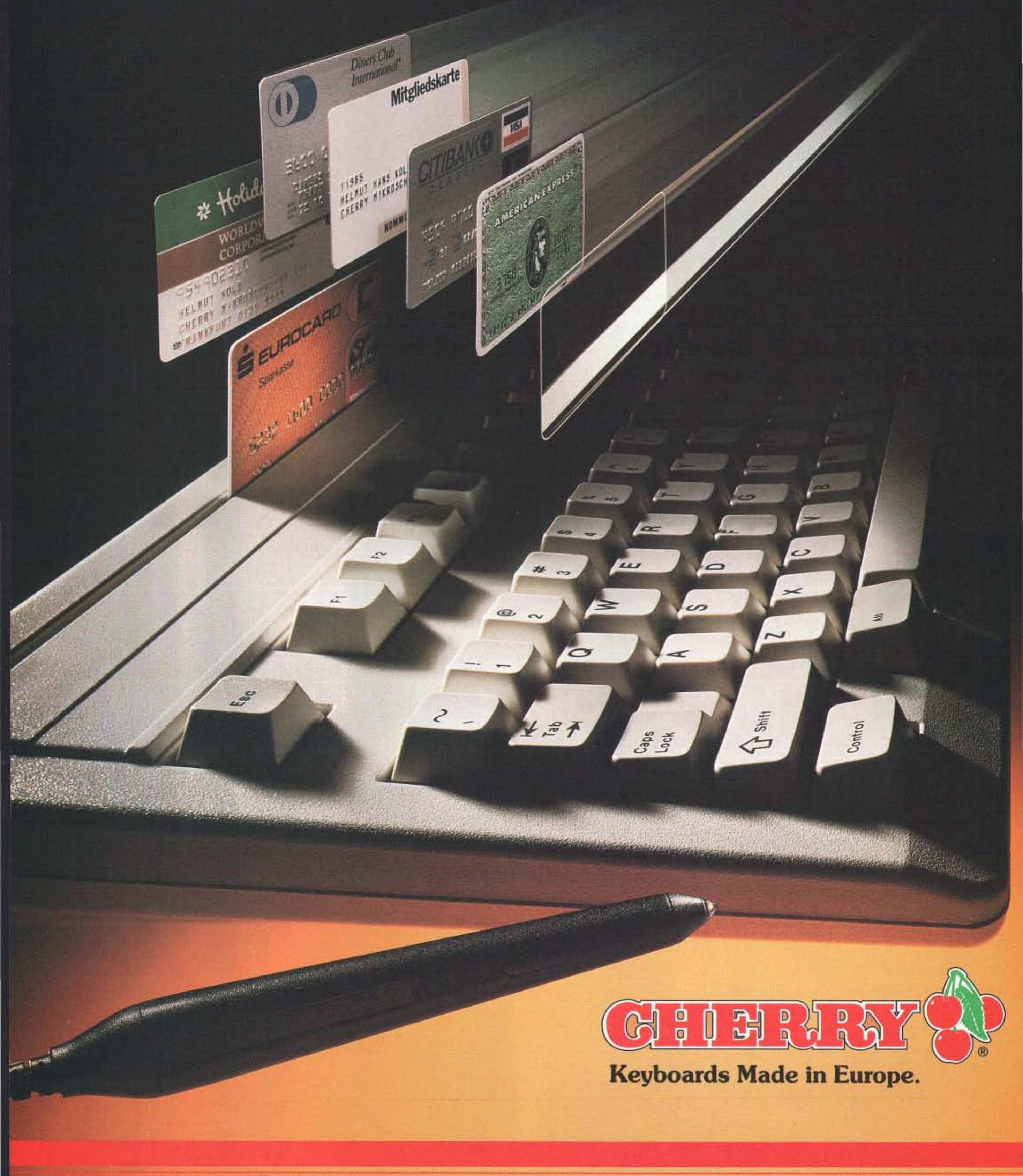

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with Palindrome's rather arcane command structure for a quarter of an hour and then in panic called Jeff Sloman, who often works with the Palindrome people. Alas, I was off by an hour on his time zone and woke him up. He was very nice about that, but he couldn't help, so I had to do the ultimate: I found the Palindrome manual. Much of that manual is no model of clarity, but one section, on how to restore an entire volume, is not only clear, but gently written in soothing language designed to produce calm. It told me to use TNARECOV, which I did. Fifteen minutes later all was well.

I fired off another fax to ATI Technologies and went to bed, disgruntled that Big Kat was still the slowest machine in the house. The next morning I talked to Jeff Sloman as well as the ATI technical-support people. They all told me the same thing: ATI makes wonderful hardware, but their drivers are perhaps not the best. Jeff put it more strongly: "When you get ATI boards, you join the driver-of-the-week club." Everyone agreed that the ATI board would work, but I should get the latest ATI drivers.

Those are available from the ATI BBS or from CompuServe. I don't currently have a CompuServe account, so there was nothing for it but to set the Demon Dialer to try to access the ATI BBS; after about 20 tries I got through. The BBS gives clear instructions, and soon I was downloading the newest driver file. There was a lot of line noise, so this took longer than I

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The **AnyView Screen Commander for Windows** ($69.95) lets you change screen resolutions without having to restart Windows. Contact **Binar Graphics, Inc.,** 30 Mitchell Blvd., San Rafael, CA 94903, (415) 491-4182; fax (415) 491-1164. **Circle 1146 on Inquiry Card.**

I like the **Bravo LP 4/33** (with 4 MB, $1467; with 8 MB, $1676; with 16 MB, $1885; 14-inch monitor, $402; 15-inch monitor, $517). Contact **AST Research, Inc.,** 16215 Alton Pkwy., Irvine, CA 92718, (800) 876-4278 or (714) 727-4141; fax (714) 727-9355. **Circle 1147.**

The **CD Sound Dimension Multimedia Upgrade Kit** ($399) is easily installed and configurable, with easy-to-understand software. It gives pretty good sound, and the CD-ROM drive is fast and reliable. Fortunately, when it was time to change the video accelerator board in Big Kat, I had a new **Graphics Ultra Pro** board ($499). Contact **ATI Technologies, Inc.,** 33 Commerce Valley Dr. E, Thornhill, Ontario, Canada L3T 7N6, (905) 882-2600; fax (905) 882-2620. **Circle 1148.**

Installing **Dr. Solomon's Anti-Virus Toolkit** (for DOS, £99; for Windows, £125; for OS/2, £149) is simple, and the program runs itself. Contact **S&S International, Ltd.,** Berkley Court, Mill St., Berkhamsted, Hertfordshire HP4 2HB, U.K., +44 442 877877; fax +44 442 877882. **Circle 1149.**

The **Library of the Future, 2nd Edition** ($299) has a number of classic works on CD-ROM, some of which aren't readily available. If you're doing scholarly work, having the texts in electronic form for searches and comparisons is a real boon. Contact **World Library, Inc.,** 12914 Haster St., Garden Grove, CA 92640, (800) 443-0238 or (714) 748-7197; fax (714) 748-7198. **Circle 1150.**

MicroProse's **Master of Orion** ($59.95) is a game of interstellar colonization, conquest, and diplomacy. If you like complex strategy games, you'll like this a lot. Contact **MicroProse,** 180 Lakefront Dr., Hunt Valley, MD 21030, (410) 771-1151; fax (410) 771-1174. **Circle 1151.**

The **Microsoft Musical Instruments CD-ROM** (PC and Mac versions, $79.95 each) has hypertext links, pictures of the instruments, explanations of the parts, sound recordings of the instruments in action, and the Sound Box, which lets you click on notes and hear the result. This CD-ROM is definitely a keeper. Contact **Microsoft Corp.,** 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1152.**

A small plastic stand with a spring to hold up your mouse tail, **Mouse Tamer** ($4.95) works wonders. I cannot imagine how I ever lived without this thing. Contact **American Business Concepts,** 4400 Sunbelt Dr., Dallas, TX 75248, (800) 877-4797 or (214) 380-8724; fax (214) 407-9096. **Circle 1153.**

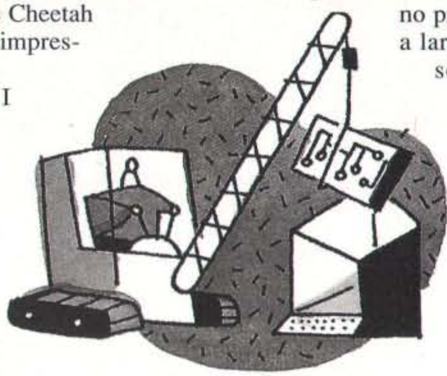
No sound board has as good quality for the money as Turtle Beach's **MultiSound** ($599). If you're serious about sound, get this board. Contact **Turtle Beach Systems,** 52 Grumbacher Rd., York, PA 17402, (717) 767-0200; fax (717) 767-6033. **Circle 1154.**

When you get your CD-ROM drive set up, use **Norton Speedrive** ($99). It does a great job of speeding it up. Contact **Symantec Corp.,** 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (408) 253-9600. **Circle 1155.**

A wonderful CD-ROM called **Twain's World** ($39.95) has everything Mark Twain wrote and includes biographical data, maps, historical background, sounds, and video; a Twain lover's delight. It's a lot more than just books on CD-ROM. Highly recommended. Contact **Bureau of Electronic Publishing,** 141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700; fax (201) 808-2676. **Circle 1156.**

thought, but eventually I had it.

Once again I took out the old board and put in ATI Technologies' Graphics Ultra Pro. Then I installed the latest ATI Mach 32 drivers, accessed Windows, and found the machine locked up to hardware reset. This time, though, I ran the ATI uninstallation program. When I went to Windows Setup, I found there was no currently installed video driver. One of my choices was the ATI Ultra Pro 1024 by 768 driver. I selected that, entered Windows without any problem at all, and when I ran Win Tachometer, I got the results shown in the second entry for the Cheetah 486DX2/33. Pretty impressive, no?



As an epilogue, I spent an hour today with ATI Technologies' technical-support people in a futile effort to make the Mach 32 driver work with this system. Eventually we gave up, concluding that there's some conflict with Windows for Workgroups 3.11. I can live without the Mach 32 driver until they get that fixed; meanwhile, it's nice to see Big Kat up there in contention as the fastest machine in the house. This certainly wasn't bad for a 4-year-old computer.

Last-minute flash: the third entry is with the Graphics Ultra Pro with Mach 32 drivers, which I was able to install by turning off the 32-bit file access capability in Windows for Workgroups. I don't know why you must do this, and neither does ATI; but wow does it ever work.

Bottom line on Windows for Workgroups: if you use Windows and are contemplating networks, seriously consider it; and if you are already using Windows for Workgroups, by all means upgrade to version 3.11. The new version fixes many bugs and glitches, although, alas, it does not solve the problem of it locking up when doing long writes across the network to optical drives. I can *read* from optical drives, and short writes are no problem; but copying a large directory can do some very weird things. More on that another time.

Meanwhile, the panting sound punctuated with cries of wild triumph you may hear in the background is Alex celebrating. He now has Windows for Workgroups 3.11 working with Novell NetWare. Much more on that next month, along with a story from the front on Microsoft versus Novell.

The gadget of the month is Mouse Tamer. This is about the simplest thing you can imagine, a small plastic stand with a spring to hold up your mouse tail. It works wonders. I used to have mouse-tail problems every hour or so. Even when the desk is covered by a paper blizzard, I can now reclaim my rodent. I cannot imagine how I ever lived without this thing. Recommended.

The computer book of the month is by Daniel P. Dern, *The Internet Guide for New Users* (McGraw-Hill, 1993); everything you need to know about getting onto the information highway. The book of the month is by Nicholas Bornoff, *Pink Samurai,* (Pocket Books, 1993); everything you ever wanted to know about the courtship, dating, and mating habits of the modern Japanese, with some interesting observations on Japanese culture.

The game of the month remains MicroProse's Master of Orion, but do be sure to download the latest bug fix patches from GEnie or the MicroProse BBS. Master of Orion is a game of interstellar colonization, conquest, and diplomacy, and, if you like complex strategy games, you'll like this a lot.

Next month: Alex and the memory monster; the new Q&A for Windows; QEMM versus EMM386; Windows for Workgroups and NetWare; and a roundup of the usual suspects. It's a great life if you don't weaken. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

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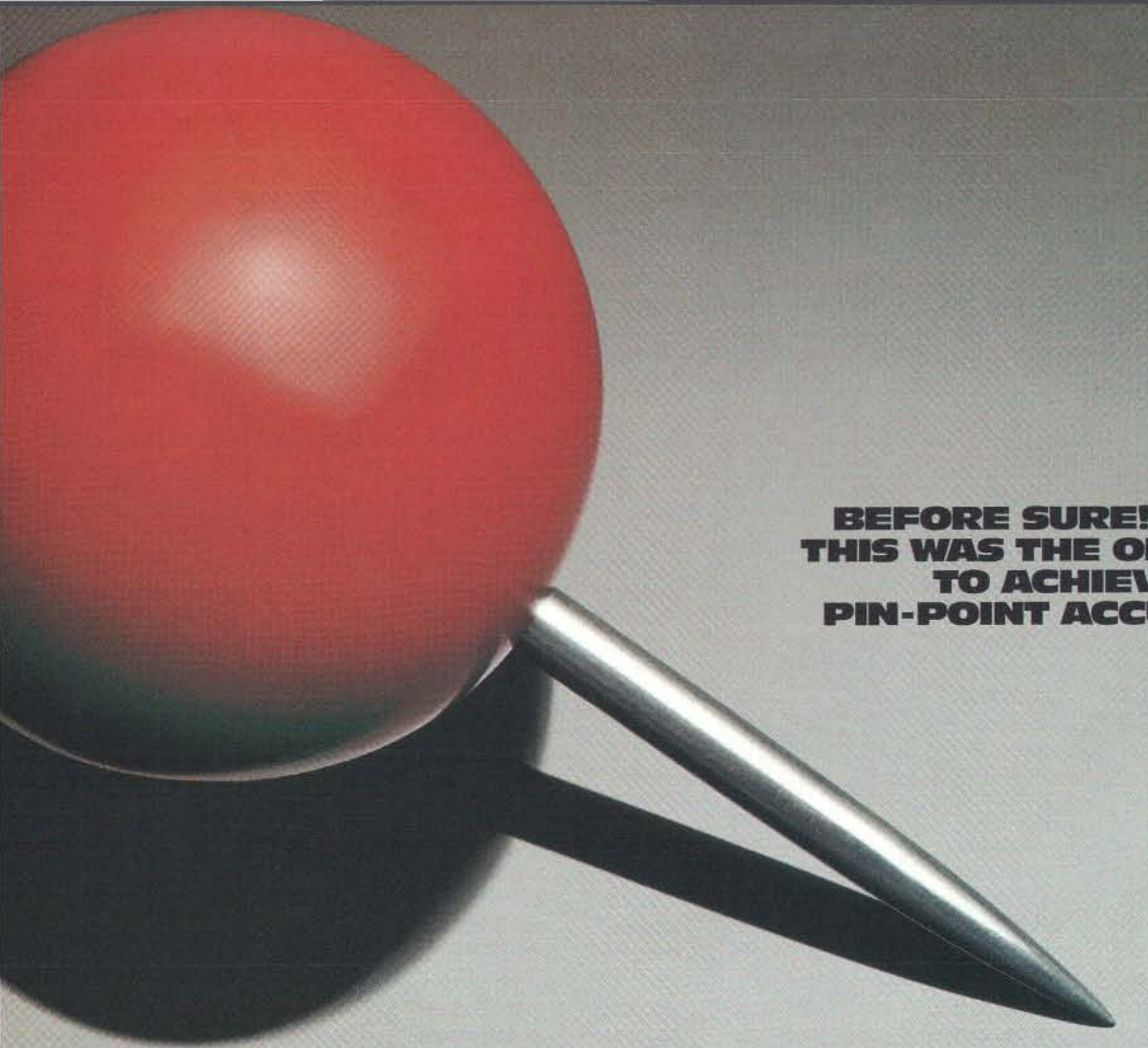

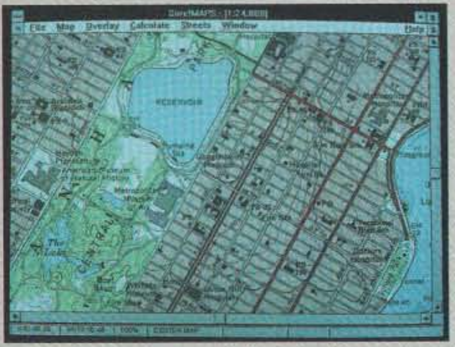

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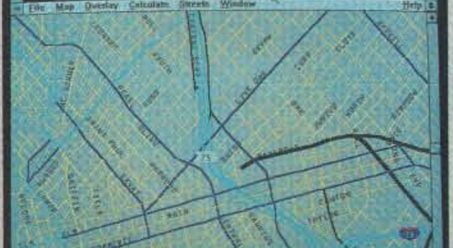

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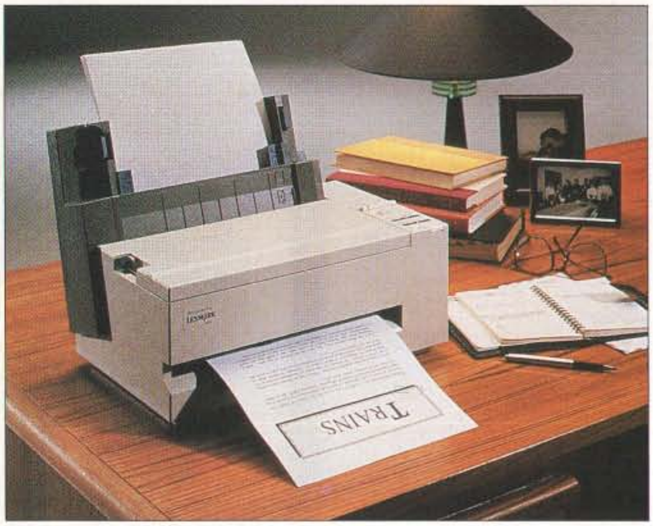

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PARALLEL-PORT BACKUP

A parallel-port tape-backup and recovery system, FileSafe SideCarII ($475) is designed for peer-to-peer networks, stand-alone PCs, and portable computers. From Mountain Network Solutions (Scotts Valley, CA), the system's integrated pass-through allows sharing of the port with a printer. The unit stores up to 305 MB of data on a single DC2120 cartridge and has a data transfer rate of up to 10 MB per minute. The system is compatible with FileSafe for Windows and ships with the company's Format-on-the-Fly, which formats the tape as it is used.

Phone: (408) 438-6650.

Circle 1323 on Inquiry Card.

SHARE A PRINTER

The Sprinter II line of printer-sharing devices (from $499) lets multiple users share multiple printers. From Belkin Components (Compton, CA), the Sprinter II queues the data in its buffer as the data is sent and then directs it to the specified printer in the order received. With four output ports on each unit, Sprinter II permits as many as four printers to be hooked up at a time. A cascade feature allows any computer to access any printer anywhere on the Sprinter II network.

Phone: (310) 898-1100.

Circle 1332 on Inquiry Card.

MULTIMEDIA PC

The Beethoven MPC-2 ($1495) is a TV-ready, 486SX-based, MPC Level 2–compliant PC. The 25-MHz Windows-based system from Wearnes Technology (San Jose, CA) includes the company's double-speed CDD-110 CD-ROM drive, which has a 307-KBps transfer rate with a burst transfer rate of 1.2 MBps. The PC has audio pass-through, letting you play standard audio CDs in the background while you're running an application. The included Beethoven Wave/DSP 16-bit stereo sound board has record and playback resolutions of from 5.5 kHz to 48.4 kHz and is compatible with most standard sound boards.

Phone: (408) 456-8838.

Circle 1331 on Inquiry Card.

PRESENTATION SYSTEMS

The Impact 256 dual-scan color passive-matrix projection system ($4995) features a wireless remote control and built-in memory that saves adjustments from previous viewing sessions. You can store up to 40 setup combinations; when the LCD panel senses the unique incoming VGA, SVGA, or Mac video signal, it automatically applies the correct setting to provide the best image. The NovaCorp (Rochester, NY) panel also has the ability to compress and display SVGA images of up to 800 by 600 pixels on the panel's 640- by 480-pixel display.

Phone: (716) 647-6510.

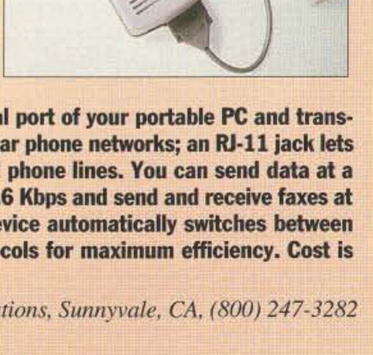
Circle 1317 on Inquiry Card.

The DPS-I ($5995) from IntelliMedia (Benton Harbor, MI) is a self-contained digital presentation system with a Windows-based software utility. You insert a 3½-inch disk containing your presentation, power up the system, and then use the infrared remote to control the presentation or add audio and video effects. Since the digital video signals are produced directly within the system, the DPS-I provides computer-generated images and full-motion video. Two internal speakers provide sound from MIDI and WAV files. The unit displays resolutions of up to 640 by 480 pixels.

Phone: (800) 706-0077 or (708) 834-7141.

Circle 1318 on Inquiry Card.

CELLULAR DATA TRANSFER



A 1-pound cellular communications device designed for use with portable computers, the AirCommunicator lets you use your current software applications to send and receive E-mail, faxes, and data files. When you unplug the device, you have a fully featured cellular phone.

The AirCommunicator connects to the serial port of your portable PC and transmits over standard cellular phone networks; an RJ-11 jack lets you connect to standard phone lines. You can send data at a transfer rate of up to 57.6 Kbps and send and receive faxes at up to 14.4 Kbps. The device automatically switches between different standard protocols for maximum efficiency. Cost is $1495.

Contact: Air Communications, Sunnyvale, CA, (800) 247-3282 or (408) 749-9883.

Circle 1309 on Inquiry Card.

NETWORK IN A KIT

The Pocket WinLAN Instant Networking Kit ($229 per PC) from Apexx Technology (Boise, ID) provides everything you need to create a workgroup consisting of two to 30 PCs. You snap the included Pocket WinLAN adapter onto your PC's parallel port, connect the PCs with the included phone cable, and install Microsoft Workgroup Add-On for Windows 3.11 (which is also included) as your networking software.

Phone: (800) 767-4858 or (208) 336-9400.

Circle 1313 on Inquiry Card.

EASY SOUND

The 16-bit AudioBlitz Classic sound card ($79) from Genoa Systems (San Jose, CA) is compatible with all industry standards, such as Sound Blaster, AdLib, and Windows Sound System. You can record and play back sound in 8- or 16-bit mode, and you have a choice of compression methods. The card includes an FM synthesizer, direct line level and microphone input for recording, and an internal 4-W amplifier to enhance output.

Phone: (800) 934-3662 or (408) 432-9090.

Circle 1319 on Inquiry Card.

NETWORK PROTECTOR

The LANMax line of power-protection devices (from $99) protects your network from power surges and spikes on your data and AC lines. The Panamax (San Rafael, CA) suppressors provide ground-reference equalization between your communications and power systems, as well as protection against ground differentials between nodes on the network. Targeted toward workstations and other equipment at the node, the devices have multiple AC outlets and RJ-11/45 (in/out) outlets. The LANMax suppressors provide protection for Ethernet 10Base-T, token ring, AppleTalk, and ARCnet running on UTP cable.

Phone: (800) 472-5555 or (415) 499-3900.

Circle 1324 on Inquiry Card.

ADD A PCMCIA SLOT TO YOUR PC

Transfer your PCMCIA drive from notebook to PC.
Put PCMCIA In Your Desktop PC
MiniStor
How To Put PCMCIA In Your Desktop
MiniStor

The DockIt Socket lets you use PCMCIA cards with your current 386 or 486 desktop PC. You simply install the DockIt Socket in a free drive bay in your unit for access to most PCMCIA Type I, II, III, and larger peripherals. The socket reads data from the card at an average data transfer rate of 230 KBps. The unit costs $249; with a MiniStor 128-MB PCMCIA card, the cost is $948.

Contact: MiniStor Peripherals, San Jose, CA, (800) 943-0165 or (408) 943-0165.

Circle 1310 on Inquiry Card.

TWO COLOR TECHNOLOGIES IN ONE PRINTER

Fargo Electronics' (Eden Prairie, MN) Photo-Realistic Upgrade Kit ($249.95) combines dye-sublimation and thermal-transfer technology in the Primera Color Printer. After you upgrade the printer driver in your PC, Mac, or Amiga, you can use your Primera to print quick proofs via wax-thermal transfer and then replace the wax-thermal-transfer ribbon with the dye-sublimation ribbon to get high-quality prints.

Phone: (800) 258-2974 or (612) 941-9470.

Circle 1320 on Inquiry Card.

PCMCIA ETHERNET

The NE4000T ($299) and NE4000 ($349) adapters connect PCMCIA-compatible notebooks to Ethernet networks. From Microdyne (Alexandria, VA), the NE4000T supports 10Base-T UTP cable. The NE4000 includes a stainless-steel base unit and a media coupler that supports BNC 10Base-2 cable.

Phone: (703) 739-0500.

Circle 1322 on Inquiry Card.

A FLEXIBLE, PORTABLE PLOTTER ▼

The Draftsman 100 portable plotter from Parallex (Indialantic, FL) produces full D-size drawings. Designed with a traveling arm, the plotter uses standard Hewlett-Packard pens that move in both the *x* and *y* axes at a speed of 9½ inches per second while the paper remains stationary. The 5-pound Draftsman 100 ($1198) can be table- or wall-mounted. Connection to your computer is via the parallel port.

Phone: (407) 952-4310.

Circle 1321 on Inquiry Card.

BAR CODE READER WITH A VOICE

With a prerecorded custom voice prompt, the TriCoder Portable Reader (from $799) lets you record up to 65 voice messages to be broadcast at specific data-entry steps and errors. You can program the reader or use the built-in default inventory programs, and you can upload to the host computer with the provided BASIC programs or your own communications program, such as Procomm or Q-Modem. The package is from Worthington Data Solutions (Santa Cruz, CA).

Phone: (800) 345-4220 or (408) 458-9938.

Circle 1315 on Inquiry Card.

VL-BUS CONTROL FOR IDE

The CSA-6210 32-bit VL-Bus IDE disk controller ($69) supports up to four IDE drives, two serial ports, and one bidirectional parallel port. From CMD Technology (Irvine, CA), the card is compatible with software features such as NetWare disk mirroring; Windows NT RAID 0, 1, and 5; Windows FastDisk; and MS-DOS driver support. Sustained transfer rates are as high as 8.2 MBps, and peak transfer rates are as high as 8.33 MBps.

Phone: (800) 426-3832 or (714) 454-0800.

Circle 1325 on Inquiry Card.

What's New Hardware

WORKGROUP DYE-SUBLIMATION PRINTER

Tektronix's new Phaser 480 is a full-bleed 11- by 17-inch dye-sublimation color printer. Its built-in support for PostScript Level 2 provides raster-image processing at speeds of less than 3 minutes for a three-pass tabloid-size page and less than 4 minutes for a four-pass color page, Tektronix says. The Phaser 480 is designed to address a wide range of graphic arts and scientific and engineering applications, and it has automatic intelligent switching among its parallel, serial, and AppleTalk ports and protocols.

The printer's base 32-MB memory is expandable to 64 MB in 16-MB increments. Using the Phaser Print plug-in for Adobe Photoshop software, you can print large Photoshop raster files across a network at nearly the speed of a dedicated, directly connected raster printer, according to Tektronix. The printer costs $14,995.

Contact: Tektronix, Wilsonville, OR, (800) 835-6100 or (503) 682-7377.

Circle 1311 on Inquiry Card.

CD-ROM FOR YOUR NETWORK

Procom Technology's (Irvine, CA) CD Tower-7 subsystem (from $2795) lets you share CD-ROM applications over a network. The CD Tower-7 has from two to seven double-speed CD-ROM drives with up to 4.2 GB of storage; you can simultaneously access data stored in any drive. The drives offer sustained data transfer rates of up to 330 KBps and an average access time of 200 ms.

Phone: (714) 852-1000.

Circle 1327 on Inquiry Card.

DISPLAY SUPER VIDEO IN WINDOWS OR DOS

Super VideoWindows-SL ($895), from New Media Graphics (Billerica, MA), displays full-motion video in a window on your PC screen. You can infinitely scale the window from full-screen size to icon size, and you can locate it anywhere on the screen while you run other applications. Super VideoWindows-SL runs in Windows or DOS and can grab individual frames of video in PCX, BMP, SVW, and TGA file formats for porting to other applications.

Phone: (508) 663-0666.

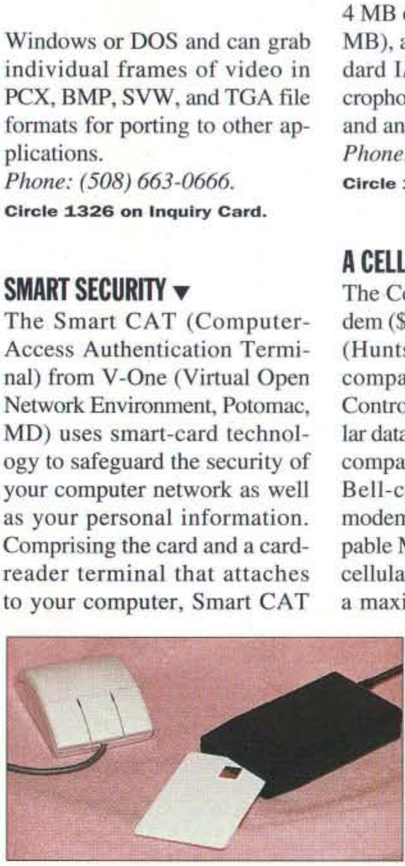
Circle 1326 on Inquiry Card.

SMART SECURITY ▼

The Smart CAT (Computer-Access Authentication Terminal) from V-One (Virtual Open Network Environment, Potomac, MD) uses smart-card technology to safeguard the security of your computer network as well as your personal information. Comprising the card and a card-reader terminal that attaches to your computer, Smart CAT ($395) operates in Windows 3.1 and works independently of your network software. A chip on the card stores information that lets you access your passwords; you activate the card via a PIN. The card encrypts files via DES with a separate key that's randomly generated for each file. In addition to storing private information, you can store information that's open to public view.

Phone: (301) 983-8362.

Circle 1312 on Inquiry Card.



VOICE ANNOTATION ON THE ROAD

The 2½-pound, 486SLC-based DTR-Sound System ($2995) provides voice annotation, business audio, and multimedia functions. From Dauphin Technology (Lombard, IL), the unit lets you perform tasks such as recording voice memos or describing a spreadsheet. The mobile system includes an internal fax modem, 4 MB of RAM (expandable to 8 MB), a 40-MB hard drive, standard I/O ports, an internal microphone, two external speakers, and an external microphone.

Phone: (708) 971-3400.

Circle 1329 on Inquiry Card.

A CELLULAR MODEM

The Cellect 14.4 PCMCIA modem ($549) from Motorola UDS (Huntsville, AL) features the company's Enhanced Cellular Control (EC²) to improve cellular data reliability while retaining compatibility with CCITT- and Bell-compliant modems. The modem connects to any data-capable Motorola MC² MicroTAC cellular phone. The modem has a maximum throughput rate of 57.6 Kbps and supports standard asynchronous speeds down to 300 bps; it also supports UUCP spoofing for high-speed Unix applications.

Phone: (205) 430-8000.

Circle 1328 on Inquriy Card.

PLUG-IN DIAGNOSTICS

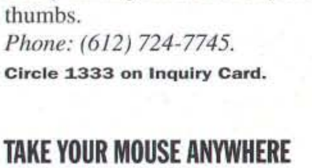
The POSTcard V2 plug-in diagnostic board ($499.95) monitors POST routines, provides continuous burn-in testing of the preboot function, and supports comprehensive system-function and component diagnostics for 386, 486, and Pentium PCs. From Unicore Software (North Andover, MA), the diagnostic board tests, sources, and pinpoints IRQ and DMA conflicts and monitors any 16-bit port address.

Phone: (508) 686-6468.

Circle 1316 on Inquiry Card.

TYPE WITH YOUR THUMBS

The Touch Edit keyboard (from $99) adds eight extra keys below the space bar that you touch-type with your thumbs. Five of the extra keys are standard editing keys, such as the arrow and delete keys; the other three are new keys that move the cursor by an entire word in either direction or delete a word. The Key Innovations (Minnetonka, MN) keyboard reduces the number of editing keystrokes by a factor of five, according to the company, and it eliminates right-wrist flexion by shifting the strokes to your thumbs.



Phone: (612) 724-7745.

Circle 1333 on Inquiry Card.

TAKE YOUR MOUSE ANYWHERE

The Mouse Slide ($24.95), from Creative Computer Accessories (Walnut Creek, CA), attaches to the bottom of most notebook computers and slides out for use as a mouse pad. You can extend the platform to either side of your notebook.

Phone: (510) 934-1930.

Circle 1330 on Inquiry Card.

The inspiration for our new Club World℠ seat.

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With an adjustable lumbar support, a newly designed footrest and the privacy of side headrests, you'll think you're flying on cloud nine. *It's the way we make you feel* that makes us the world's favourite airline.

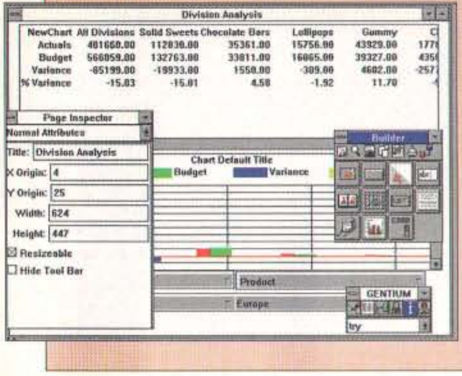
BRITISH AIRWAYS
The world's favourite airline®

Circle 74 on Inquiry Card.

What's New Software

DROP AND DRAG GROUPS ACROSS DISPARATE PLATFORMS

The Gentium eis 1.0 analytical applications development environment is a multiplatform system for use with EIS/DSS (Executive Information Systems and Decision Support Systems). According to Planning Sciences, Gentium uses open-systems design standards and features a point-and-click object-oriented interface, unlimited data access, and cross-platform portability. All EIS/DSS features, such as multidimensional databases, data modeling, matrix reporting, charts and graphs, and exception reporting, are provided as objects that you can assemble and reuse without writing code.



NewChart	All Divisions	Solid Sweets	Chocolate Bars	Lollipops	Gummy
Actuals	481660.00	112838.00	35361.00	15756.00	43929.00
Budget	566059.00	132763.00	33811.00	16065.00	39327.00
Variance	-85199.00	-19933.00	1550.00	-309.00	4602.00
% Variance	-15.03	-15.01	4.58	-1.92	11.70

Title: Division Analysis
X Origin: 4
Y Origin: 25
Width: 624
Height: 447
☒ Resizeable
☐ Hide Tool Bar

Gentium lets you create workgroups encompassing users across disparate platforms and networks. Users can retain the operating-system interface they are most familiar with, share information concurrently within a group, and be moved from group to group. Cost is $2340 per user for 25 users or $1222 per user for 100 users.

Contact: Planning Sciences, Roswell, GA, (404) 772-9767.

Circle 1271 on Inquiry Card.

WORKGROUP DATA SHARING

The network version of askSam for Windows ($1095 for five users) is a free-form database that combines database, word processing, text-retrieval, and OLE functions. From askSam Systems (Perry, FL), the software lets you share unstructured data such as personal notes, E-mail, marketing information, and government regulations.

Phone: (800) 800-1997 or (904) 584-6590.

Circle 1275 on Inquiry Card.

ZANY FONTS ►

Font-o-Matic ($59.95), a utility from Altsys (Richardson, TX), enables you to create unusual TrueType fonts from any TrueType or PostScript Type 1 font. Via the GUI you can enlarge, rotate, or skew your fonts and then add designs such as cow spots, swiss-cheese holes, or cactus prickles to a copy of the original font. Each new font is accessible from any Windows application.

Phone: (800) 477-2131 or (214) 680-2060.

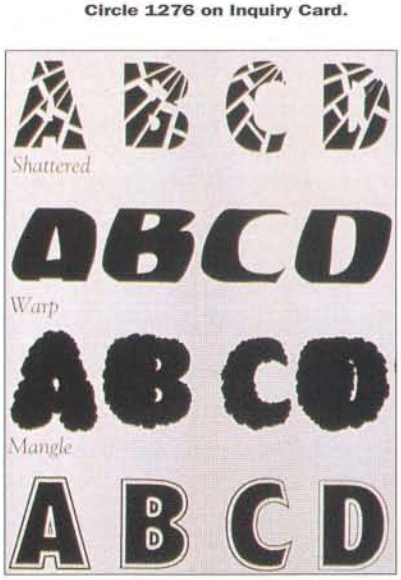
Circle 1283 on Inquiry Card.

TCP/IP FOR DOS AND WINDOWS

A TCP/IP package, Piper/IP ($375) uses less than 6 KB of base memory and has a data transfer rate of up to 500 KBps. From Ipswitch (Wakefield, MA), Piper/IP has a Winsock interface and is compatible with NetWare, Vines, LAN Manager, LAN Server, and Windows for Workgroups. The package has a set of TCP/IP utilities, NetBIOS, and an SNMP agent. Support is included for SQL databases, terminal emulators, the X Window System, and Internet utilities.

Phone: (617) 246-1150.

Circle 1276 on Inquiry Card.



EASY 3-D ANIMATION

3D Choreographer ($149.95), from AniCom (Columbia, MD), offers a no-fuss way to integrate 3-D animation into your presentation, report, or multimedia production. You select an actor by clicking on an icon and then draw a path that is divided into time points for the actor to follow. You use commands to tell the actor what to do. You can also create your own actions (or complex actions via layering multiple actions). The package supports OLE and generates animation files in Autodesk FLC format, allowing you to use 3D Choreographer as a stand-alone package.

Phone: (800) 949-4559 or (410) 799-1060.

Circle 1277 on Inquiry Card.

ADD ZIP TO WINDOWS

The DynaZIP Data Compression Library for Microsoft Windows ($295 per developer station) lets you incorporate into your programs the capability to read, test, create, modify, and write industry-standard ZIP files without having to shell to DOS. Compatible with any DLL-capable high-level language such as C, C++, and Visual Basic, the Inner Media (Hollis, NH) package provides information about ZIP file items, dual-progress monitor callback capabilities, and status and error reporting.

Phone: (603) 465-3216.

Circle 1278 on Inquiry Card.

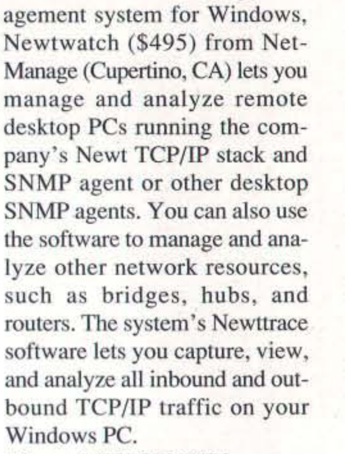
NETWORK DESKTOP MANAGER

An SNMP-based desktop management system for Windows, Newtwatch ($495) from NetManage (Cupertino, CA) lets you manage and analyze remote desktop PCs running the company's Newt TCP/IP stack and SNMP agent or other desktop SNMP agents. You can also use the software to manage and analyze other network resources, such as bridges, hubs, and routers. The system's Newttrace software lets you capture, view, and analyze all inbound and outbound TCP/IP traffic on your Windows PC.

Phone: (408) 973-7171.

Circle 1279 on Inquiry Card.

CALCULATE IN WINDOWS



A six-in-one calculator utility for Windows, MasterCalc ($49) includes Mini, Math, Business, Statistical, Unit, and Programmer's calculators. From Borys (Hanover Park, IL), MasterCalc includes user-friendly graphics; a 15-digit precision rounding option; an unlimited, easy-to-access memory location; and pop-up windows. MasterCalc supports display formats, such as decimal, scientific, fractional, and combined, which you can customize. You can choose different formats for input and output and control conversions from one representation to another.

Phone: (708) 837-9680.

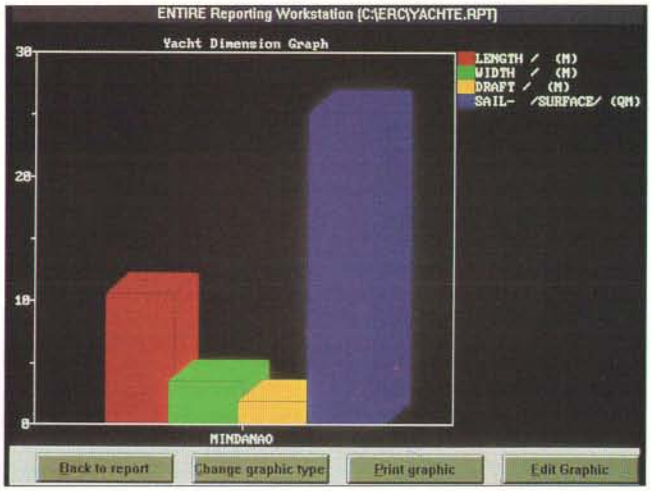
Circle 1281 on Inquiry Card.

PUT SERVER CAPABILITY ON YOUR PC ▶

Entire Reporting Workstation for Windows (from $270 per copy) lets you use Windows to access enterprise data from multiple files and bring it to your desktop PC for additional processing and analysis. From Software AG (Reston, VA), Entire Reporting Workstation allows you to export and import reports into other formats, letting you use the information in applications such as Excel or Word.

Phone: (703) 860-5050.

Circle 1287 on Inquiry Card.



GET COMPUTER CLOCK ACCURACY

Clockwright ($39), a utility from Barberry Hill Software and Engineering (Woodstock, VT), maintains the exact time on PCs running DOS, Windows, or OS/2. Able to reduce the error of the system clock to 1 second per week or less, Clockwright calculates clock-speed error after two clock corrections are made. The program automatically corrects the clock setting during start-up or any other mandated time. You can switch among standard, daylight saving, universal, or local-mean-time modes.

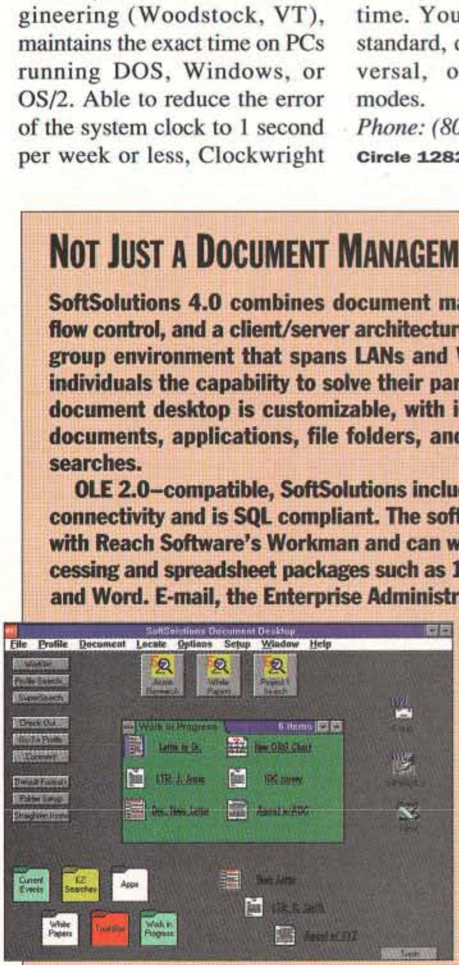
Phone: (802) 457-2654.

Circle 1282 on Inquiry Card.

NOT JUST A DOCUMENT MANAGEMENT SYSTEM

SoftSolutions 4.0 combines document management, workflow control, and a client/server architecture to create a workgroup environment that spans LANs and WANs, yet it gives individuals the capability to solve their particular needs. The document desktop is customizable, with icons representing documents, applications, file folders, and saved document searches.

OLE 2.0–compatible, SoftSolutions includes open database connectivity and is SQL compliant. The software is integrated with Reach Software's Workman and can work with word processing and spreadsheet packages such as 1-2-3, WordPerfect, and Word. E-mail, the Enterprise Administrator, and the fuzzy logic–based Intelligent Search are included. Cost is $495; additional workstations are $295 each.



Contact: SoftSolutions Technology, Orem, UT, (801) 226-6000.

Circle 1272 on Inquiry Card.

YOUR OWN LAN MECHANIC

LAN Mechanic (from $199) is a network management utility for Artisoft LANtastic networks. From Micro Mechanic (Boulder, CO), LAN Mechanic features a repair module for network shared-resource hard drives, an unattended hard drive integrity-check module, capacity thresholds for hard drives, alerts for DOS and Windows screens as well as for the paging module, and a remote editor for workstations and file servers. A view manager for each file server and workstation shows RAM availability, resource use, and a system and memory summary.

Phone: (303) 443-0091.

Circle 1280 on Inquiry Card.

JOB SCHEDULING MADE EASY

EcoScheduler (from $8000) lets you schedule batch jobs for your enterprise system based on calendar events, the status of other jobs, and the level of resources required by a job. You can use the Compuware (Farmington Hills, MI) software to schedule a job or groups of jobs and specify limits on the amount of computer and database resources used by a job. EcoScheduler maintains a log of the current status of all jobs, which you can view, print, and manipulate.

Phone: (313) 737-7300.

Circle 1285 on Inquiry Card.

Software Update

Saber LAN Workstation 2.0, Saber Software (Dallas, TX), adds centralized file and software distribution, an advanced programming language, remote alarm notification, a desktop launching utility, and a control panel that replaces the Windows control panel. From $179.

Phone: (800) 338-8754 or (214) 361-8086.

Circle 1288 on Inquiry Card.

BookWise 2.0, Xerox Imaging Systems (Peabody, MA), includes an advanced version of the company's OCR software, editing capabilities from within the BookWise program and file management, compatibility with Hewlett-Packard's scanners, and automatic page orientation. $1295.

Phone: (800) 248-6550 or (508) 977-2000.

Circle 1289 on Inquiry Card.

Learn to Speak Spanish 4.0, HyperGlot Software (Knoxville, TN), features 60 QuickTime or QuickTime for Windows movies, a 350-page workbook, and an enhanced interface. $149.

Phone: (800) 726-5087 or (615) 558-8270.

Circle 1290 on Inquiry Card.

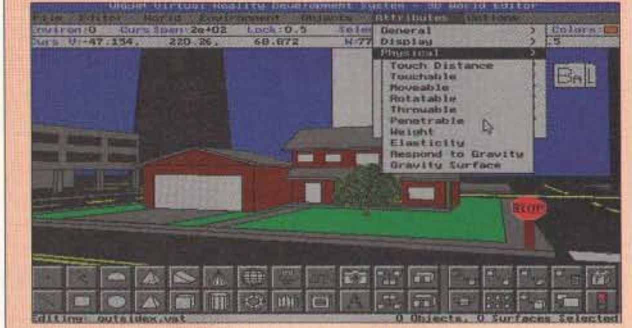
Opti-Net NLM 2.0, Online Computer Systems (Germantown, MD), is Novell certified and provides new diagnostics, improved administration functions for large database manipulation, client caching, seamless use across NetWare 3.x and 4.x operating systems, access to logical-unit-number CD-ROM drives, and support for ISA SCSI host adapters in servers that are equipped with more than 16 MB of RAM. $1495 for a 100-workstation license.

Phone: (800) 922-9204 or (301) 428-3700.

Circle 1291 on Inquiry Card.

What's New Software

CREATE YOUR OWN WORLD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File Editor World Environment Objects Attributes Options
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Colors:
General
Display
Physical
Touch Distance
Touchable
Moveable
Rotatable
Throwable
Penetrable
Weight
Elasticity
Respond to Gravity
Gravity Surface
STOP
Editing: outsidex.vwt
0 Objects, 0 Surfaces Selected

The Vream Virtual Reality Development System lets you draw whatever objects you want in your 3-D world using a set of 3-D drawing tools within the Vream 3D World Editor. To make your virtual world interactive, you define the logical link structures of the objects. After you've defined your world, you can enter it and interact with it in real time using the Vream Runtime System. You can walk through your creation and then grab and move objects with the virtual hand to activate the linked structures. The package costs $795.

Contact: Vream, Chicago, IL, (312) 477-0425.

Circle 1273 on Inquiry Card.

LONG FILENAMES PERMISSIBLE

A Windows- and DOS-compatible document manager that lets you create file and directory names up to 255 characters long, QuickFind ($49.95) works from within your application. From View Software (Palo Alto, CA), QuickFind lets you give meaningful names to your files, offering an intuitive alternative to file-searching and indexing systems. Integrated with an application, QuickFind enhances the File Open and File Save As commands and dialog boxes; it also provides a migration path to long filenames that are native to Windows NT.

Phone: (800) 487-8439 or (415) 856-8439.

Circle 1284 on Inquiry Card.

CROSS-PLATFORM CD-ROM

The QuickView multimedia viewer for Macs (developer's kit, $495) emulates the functionality of Microsoft's Multimedia Viewer 2.0. From Altura Software (Pacific Grove, CA), QuickView lets you develop CD-ROM titles that will play on Macs and in Windows. The software includes complete file compatibility with HPJ and RTF files; context-sensitive help; hypertext links; and PICT, BMP, and segmented hypergraphics support. QuickView also supports Mac sound files and Windows WAV files, embedded panes and windows, full text search and retrieval, external commands, and support for QuickTime and AVI movies.

Phone: (408) 655-8005.

Circle 1286 on Inquiry Card.

WRITE IN KANJI IN WINDOWS

A Japanese word processor for Windows, KanjiWord ($199) has a fully configurable kana/kanji front-end processor that allows you to enter Japanese phonetically using an English keyboard. Pacific Software Publishing's (Mercer Island, WA) package comes complete with two built-in fonts: a 16-pixel Japanese bit-map font for on-screen viewing and a 48-pixel Mincho-Japanese bit-map font that provides clean Japanese output.

Phone: (206) 232-3989.

Circle 1303 on Inquiry Card.

SAFE PASSAGE FOR E-MAIL

MailWatch (from $5000) alerts network administrators and mail recipients on a multiplatform LAN of blockages that prevent the delivery of E-mail. The Uniplex Enterprise Systems group (Greenwich, CT) tool monitors E-mail systems such as cc:Mail via graphical representation of the mail network and provides early warning of problems. One PC can monitor an entire mail network, or Mail Agents installed at several points throughout the network can do the monitoring.

Phone: (203) 661-4404.

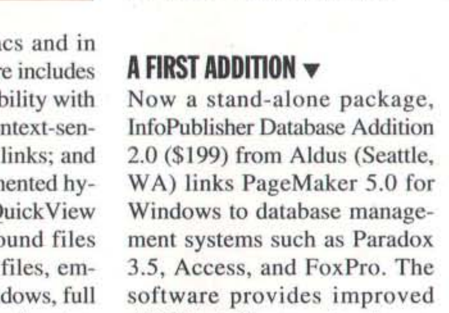
Circle 1338 on Inquiry Card.

A FIRST ADDITION ▼

Now a stand-alone package, InfoPublisher Database Addition 2.0 ($199) from Aldus (Seattle, WA) links PageMaker 5.0 for Windows to database management systems such as Paradox 3.5, Access, and FoxPro. The software provides improved ASCII text-file support and complies with Microsoft's ODBC protocol. Features include the ability to launch InfoPublisher as an Addition from within PageMaker and automatic updates to reflow stories based on data or format changes.

Phone: (206) 622-5500.

Circle 1305 on Inquiry Card.



Software Update

Raosoft Survey 2.5, Raosoft (Seattle, WA), offers additional options for forms design, additional capacity in analysis and reports, expanded data-entry support, and an intuitive calculation option. $495.

Phone: (206) 525-4025.

Circle 1292 on Inquiry Card.

Corel Ventura 4.2, Corel (Ottawa, Ontario, Canada), combines Ventura Publisher, DataBase Publisher, support for Adobe Acrobat, and faster font loading. $249.

Phone: (800) 772-6735 or (613) 728-8200.

Circle 1293 on Inquiry Card.

Insync 1.1, Synergy Solutions (Mesa, AZ), includes a two-port version of Modem Assist Plus network modem sharing. $495.

Phone: (602) 545-9797.

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Rescue 5.0, AllMicro (Clearwater, FL), gives you the ability to recover data from compressed drives, bypasses bad or destroyed partitions and root-directory damage to recover by filename, lets you choose which FAT to use, and is friendlier and quicker. $349.

Phone: (800) 653-4933 or (813) 446-6660.

Circle 1295 on Inquiry Card.

DeltaGraph Pro 3, DeltaPoint (Monterey, CA), has been redesigned with a streamlined interface and now has a multiview configuration. New are 13 charts; a charting engine; a chart advisor; support for multiple documents; compatibility with Pantone ColorUP; and eyedropper, shadow, and blend tools. $195.

Phone: (408) 648-4000.

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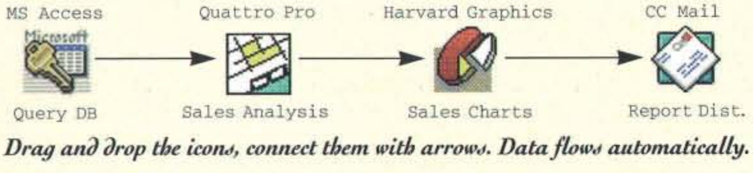

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What's New Software

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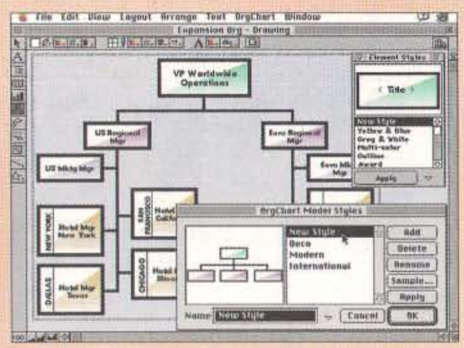

ClarisImpact 1.0 for Macintosh automatically creates the graphics you define and updates them when you specify changes. With its integrated word processing capability, ClarisImpact creates reports and memos with business graphics, automatically wrapping text around the graphics. The software enables you to create slide presentations with professionally designed backgrounds and special effects. The Claris graphics engine provides seamless cross-platform compatibility between Macintoshes and Windows for Claris graphics products. The package costs $399.

Contact: Claris Corp., Santa Clara, CA, (408) 987-7000.

Circle 1274 on Inquiry Card.

ACCESS UNIX FROM OS/2

XoftWare/32 3.0 (from $395) is now available for OS/2 platforms in addition to Windows. From AGE Logic (San Diego, CA), XoftWare/32 lets you use your PC to access and display network-based Unix applications simultaneously with OS/2, Windows, and DOS applications. Features include a comprehensive Network File Manager utility with file transfer and local printing capabilities, an interactive Telnet client, and a Windows- and OS/2-based Trace utility. The Windows version adds a Unix print reroute utility, support for installation from a remote server, and 24-/16-bit color support.

Phone: (619) 455-8600.

Circle 1302 on Inquiry Card.

OS/2 SCHEDULER

Sytos Scheduler ($99) is a scheduling utility for Presentation Manager that runs automated or background events, such as command and executable files, under OS/2. Sytos Scheduler enables you to plan single or multiple scheduled events to run once or according to your specified schedule. You can specify the start and end times and dates and exclude events from running on certain dates, such as holidays. You can use the Sytron (Westborough, MA) utility as a stand-alone scheduling utility for OS/2 or as an enhanced scheduler for Sytos Plus for OS/2 procedures.

Phone: (508) 898-0100.

Circle 1337 on Inquiry Card.

SCREEN-SAVER SELECTION

Art and photographic images are the mainstay of Second Nature Software's (Portland, OR) 30 screen-saver/wallpaper collections for Windows 3.1 ($15 per collection). Each collection has 22 256-color images such as butterflies, national parks, impressionist paintings, classic cars, and space voyages.

Phone: (503) 291-9500.

Circle 1307 on Inquiry Card.

Claris Clear Choice's (Santa Clara, CA) Imaginaria ($49) is a multimedia screen-saver collection for Windows. Images, 11 animated transition screens, and 15 surrealistic story modules come with original sounds and music.

Phone: (408) 987-7000.

Circle 1308 on Inquiry Card.

HOP OVER TO PROBABILITY CALCULATIONS ▼

The Electronic Handbook of Probability, or eHop ($49), calculates p values and percentage points for 28 probability distributions. The Windows 3.1 utility provides distribution statistics, formulas, random samples, and graphical output for each distribution. From Crunch Software (Oakland, CA), eHop also provides information and references for each distribution.

Phone: (510) 562-9900.

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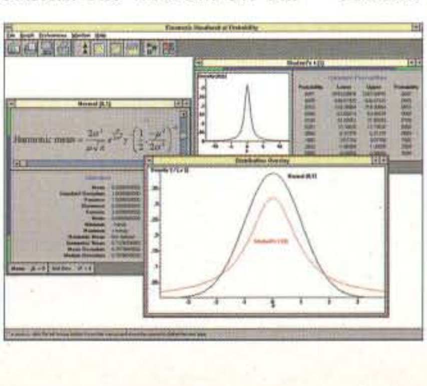

SIMPLICITY IS A PIM

An entry-level PIM, Ecco Simplicity ($149) has an intuitive start-up screen that lets you start working quickly. From Arabesque (Bellevue, WA), Ecco Simplicity has profession-specific templates that access Ecco Professional's dynamic information-linking abilities. Graphical calendar views display the month and week at a glance; to-do items can be in color to help distinguish them from appointments. Calendar, phone book, and outline views are integrated, so you don't have to enter your information more than once.

Phone: (206) 885-4272.

Circle 1306 on Inquiry Card.

Software Update

SCSI Director Professional 3.0, Transoft (Santa Barbara, CA), features integrated driver support for major CD-ROM formats, supports Apple's SCSI Manager 4.3, and is SCSI-2 compatible. $199.

Phone: (805) 565-5200.

Circle 1297 on Inquiry Card.

PacketView 1.10, Klos Technologies (Merrimack, NH), supports the Open Data-Link Interface, expands support for the NetBIOS protocol, provides enhanced data-sharing with the Network General Sniffer, adds symbolic support for SNMP Object IDs, and supports FDDI networks. $299.

Phone: (603) 424-8300.

Circle 1298 on Inquiry Card.

Coherent 4.2, Mark Williams Co. (Northbrook, IL), can run over 50 third-party software packages, adds a user-interface shell and a Unix System V–style print spooler, and supports SCSI and floppy tape drives. From $99.95.

Phone: (708) 291-6700.

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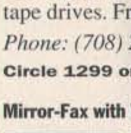

Mirror-Fax with Voice 2.0, SoftKlone (Tallahassee, FL), features data, fax, and voice capabilities and supports Cirrus Logic, Rockwell, Sierra, and ZyXel data/fax/voice chip sets. $99.

Phone: (904) 878-8564.

Circle 1300 on Inquiry Card.

Trak/Report 2.0, Concord Communications (Marlborough, MA), adds group-capacity-planning capability, faster performance, enhanced database functionality, and support for token-ring and bridged networks. $7500.

Phone: (508) 460-4646.

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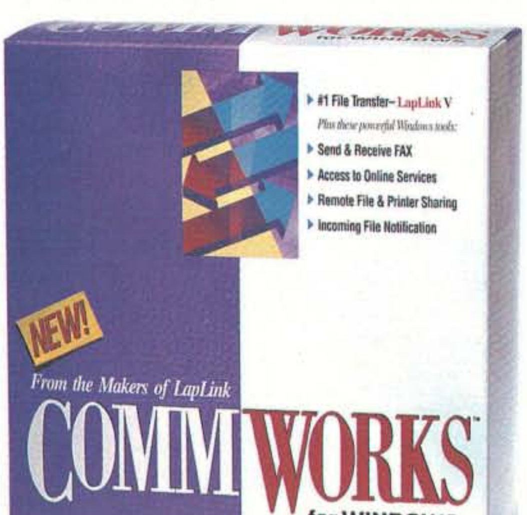
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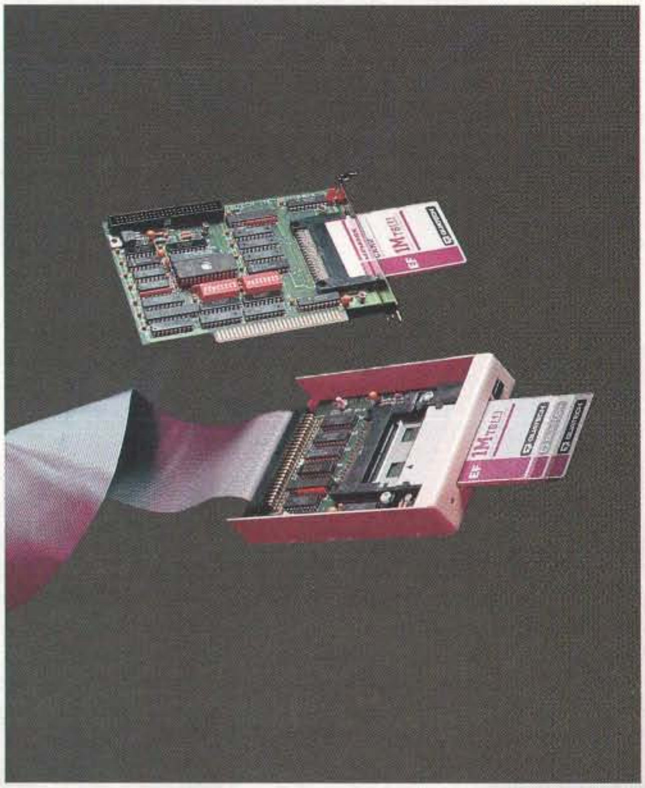

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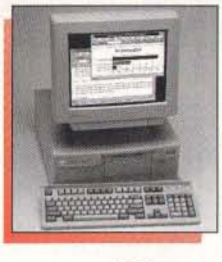

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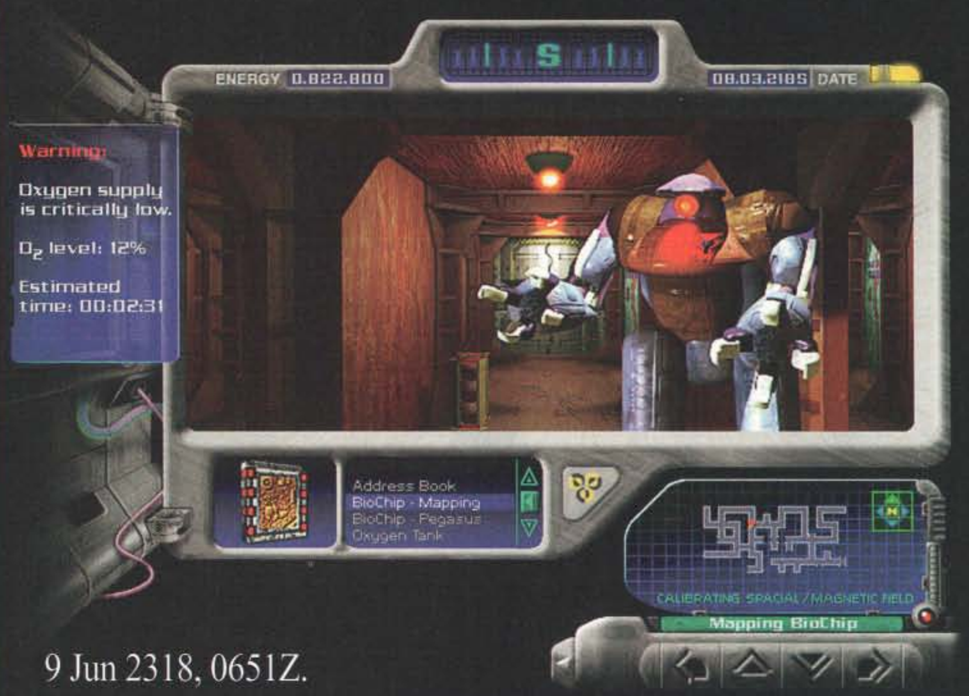

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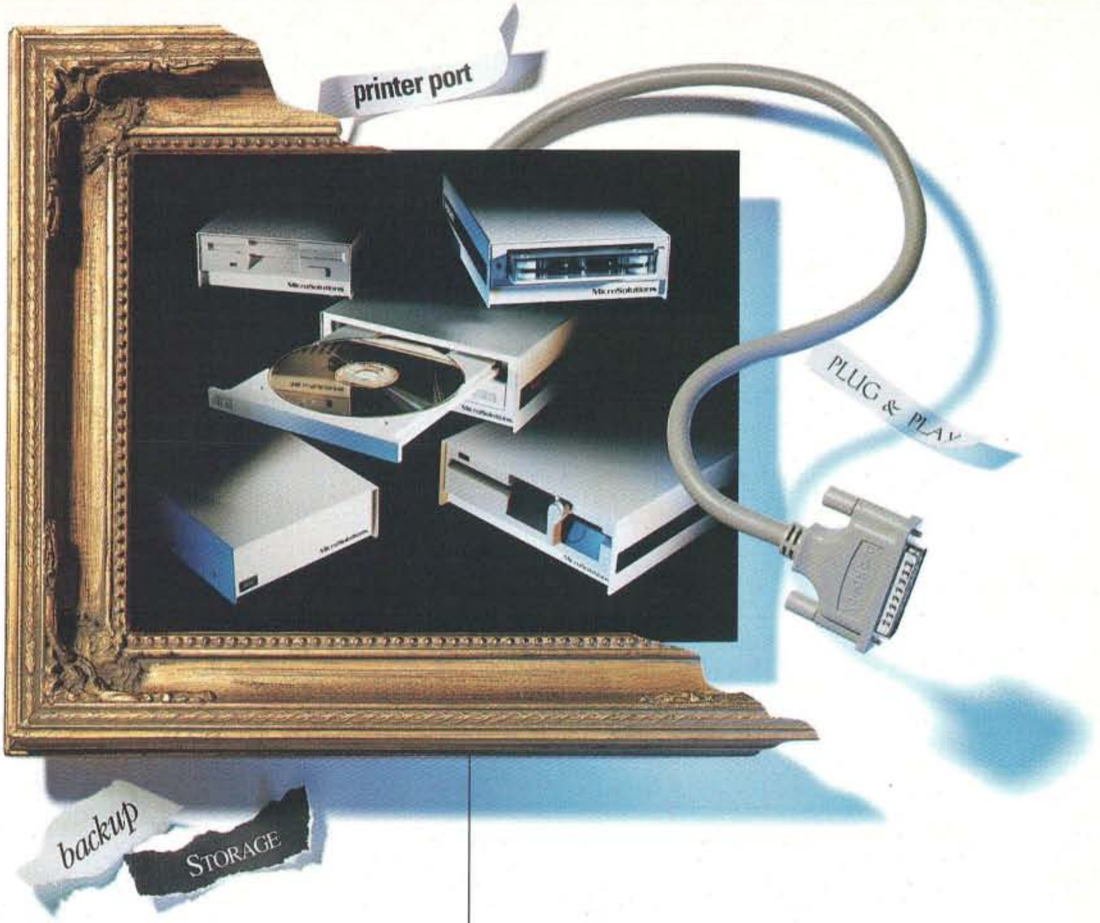

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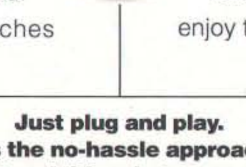

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8Kx8	–	6.50	6.00	5.50
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Intel SL Mobil	85.00
Intel 16SX	49.00
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- **Uses industry standard math chip**
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16Meg x 9 (36 chip)	–	–	–	–	–	–

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2 x 36 8Meg (w/pal)	–	–	449.00	429.00	379.00	–
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4 x 36 16Meg		–	709.00	679.00	679.00	–
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	4Meg	500987-002	199.00
	8Meg	500987-003	419.00
	16Meg	500987-004	619.00
	32Meg	500987-005	1399.00
Premium 486/25, 25E, 33, 33E Premium 386/33TE, 486/25TE, 33TE Prem. Serv., Prem II 386SX/20, 25 Prem. II 386/25, 386/33, 486/33, 486SX/20	8Meg	500780-001	398.00
Premium 386/33T, Prem. 386SX/16 Prem. II 386SX/20, 25		500780-004	189.00
Premium 386/25, 33, 386/331, 386SX/16,		500780-003	59.00
Prem. II 386SX20,25		500780-001	59.00
Premia	8Meg	501159-002	CALL
Premia	16Meg	501159-003	CALL
Premia	32Meg	501159-004	CALL
Premia	64Meg	501159-005	CALL

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386/33, 25, 20, 33E	1Meg	ZA3800ME	59.00
Z386/33, 25, 20, 33E, 486/25E	4Meg	ZA3800MK	195.00
Z386SX	2Meg	Z-605-1 modules	119.00

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30F5360 (2Meg)	30-286, 25-286, 50 MTHR BD.	104.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 161	84.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	170.00
6450604 (2Meg)	70-061, E61, 121, 50Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	89.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	185.00
87F9977 (4Meg)	55SX, 55LS, 65SX, 40SX, 35SX, 35LS	185.00
1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	99.00
92F9694 (4Meg)	P/S1 & P/S1/386SX, Model-2121	189.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	95.00
6450128 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486CS2, 486SX, SVR85 Value Point 77 486DX2, 486SX, SVR 85	189.00
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79F1000 (4Meg)	LX40, N33SX, PS Note, Thinkpad 350, 350c	199.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
07G1826 (2Meg)	N51 (all)	103.00
07G1827 (4Meg)	N51 (all)	199.00
07G1828 (8Meg)	N51 (all)	419.00
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07G1416 (8Meg)	Thinkpad 750, 750c	449.00
66G0094 (16Meg)	Thinkpad 750, 750c	1149.00
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07G1421 (8Meg)	CL57LSX LpTp, Thinkpad 700, 700C, 720, 720C	439.00
60G0378 (8Meg)	Thinkpad 350, 350c	359.00
60G0379 (16Meg)	Thinkpad 350, 350c	759.00
92F8804 (2Meg)	N45SL	109.00

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MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
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	8Meg Module	116561-001	429.00
	32Meg Module	116568-001	1459.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	209.00
DeskPro 386S-16MHz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	329.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	229.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	329.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	229.00
DeskPro 286N, 386N, 386SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1Meg Module	118688-001	59.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	183.00
Port. 486C	8Meg Module	128877-001	399.00
M Series Exp Bd	0-64Meg	129160-001	279.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
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DeskPro 286	512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M	8Meg Kit	149911-001	389.00
DeskPro 5/60, 5/66M	16Meg Kit	149949-001	769.00
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Prolinea 386 3/25S, 3/25ZS	2Meg	141738-001	109.00
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Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS	2Meg	141683-001	95.00
	4Meg	141684-001	189.00
	8Meg	141685-001	429.00
Prosignia PC Server, 486/33, 486 DSX/66	8Meg	141685-001	429.00
	16Meg	149320-001	689.00
	32Meg	149147-001	1525.00
Prosignia 5/60	16Meg	139132-003	739.00
Prosignia 5/60	32Meg	139132-004	1659.00
Prosignia 5/60	64Meg	139130-001	2799.00
Prosignia 5/60	128Meg	139132-007	6199.00

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LTE/286	4Meg Bd	117081-003	179.00
LTE/386S/20	4Meg Module	121125-002	239.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	239.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	399.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	809.00
LTE LITE 4/25C, 4/23E, 433C	4Meg Module	142337-002	219.00
LTE LITE 4/25C, 4/23E, 433C	8Meg Module	142337-003	429.00
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SLT/386	4Meg Module	118305-001	219.00
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	4Meg	139498-001	189.00
	8Meg	139499-001	369.00
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Card Pro (made by Data I/O) Transfers data from PCMCIA card to desktop PC, connects to a parallel port	299.00	2400/9600 Data/Fax Modems	179.00
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T2000/T2000SX	2Meg	PC18-PA8317U	94.00
T2000SX/T1000LE	4Meg	PC-PA8314U	219.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	419.00
T2000SXE/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	94.00
T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	219.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	419.00
T4400SX, SXC T6400	4Meg	PC-PA2004U	219.00
T4400SX, SXC T6400	8Meg	PC-PA2005U	419.00
T4400SX, SXC T6400	16Meg	PC-PA2010U	713.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	4Meg	PC-PA2012U	249.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	8Meg	PC-PA2013U	479.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	16Meg	PC-PA2014U	1399.00
T3300SL	4Meg	PC-PA2007U	234.00
T3300SL	6Meg	PC-PA2008U	349.00
T3300SL	8Meg	N/A	489.00
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T1600	2Meg	PC8-PA8302U	99.00
T3100	2Meg	PC3-PA7135E	179.00
T3100e	2Meg	PC9-PA8340U	109.00
T3100SX	2Meg	PC15-PA8308U	109.00
T3100SX	4Meg	PC15-PA8310U	209.00
T3200	3Meg	PC6-PA7137U	185.00
T3200SX	2Meg	PC12-PA8307U	119.00
T3200SX	4Meg	PC12-PA8909	209.00
T3200SXC	2Meg	PC19-PA8318U	119.00
T3200SXC	4Meg	PC19-PA8319U	219.00
T5100	2Meg	PC7-PA8301U	95.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

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ACER 750	4Meg/8Meg/16Meg		199/459/869
ALR Venture	4Meg	12407980	279.00
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25C, 425EL	4Meg		199.00
AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501168-001	199.00
AST Power Exec 425SL	16Meg	501168-003	819.00
AT&T Safari NSX/20	4Meg	PEC 37651	299.00
Bondwell B310, Plus	1Meg	23050-09100	109.00
Bondwell B310V, SX	1Meg		109.00
Bondwell B310V, SX	4Meg		229.00
Epson NB3	4Meg	A808511	199.00
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00053-0001	99.00
Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		199.00/1549.00
Goldstar GS520 386SX/16	4Meg	S386-4M	299.00
Magnavox Metalis	1Meg, 4Meg	286, 386SX	109.00,199.00
NEC Prospeed 286, 386SX-16	1Meg	PC21-21	79.00
NEC Prospeed 286, 386SX-16	4Meg	PC21-22	199.00
NEC Prospeed 386	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 386SX-20	1Meg	PC43-21	79.00
NEC Prospeed 386SX-20	4Meg	PC43-22	199.00
NEC Ultralite III/20, 20P, 25C	2Meg	PC47-21	109.00
NEC Ultralite III/SL/25C	4Meg	PC47-22	199.00
NEC Ultralite SL/20, 20P	6Meg	PC49-21	309.00
NEC Ultralite III/25C	8Meg	PC47-23	389.00
NEC Ultralite Versa	4 Meg/8Meg/16Meg/20Meg	OP4104	209, 429, 849, 104
Packard Bell 386SX, 286	1Meg, 4Meg	286, 386SX	109,199
Panasonic CF170, CF270, CF370	1Meg	CF-BA165	49.00
Panasonic CF380	2meg/4Meg/6Meg		CALL/CALL/CALL
Panasonic CF480	2Meg/6Meg		CALL/CALL
Sanyo 17/18 NB	2Meg	MBC-NBMEM2	99.00
Sharp 6781, 6881, 6785	2Meg/4Meg		109.00/199.00
Sharp PC-6220	1Meg	CE 621B	79.00
Tandon, PC Brand, Dataworld	2Meg, 8Meg	NB386SX-20	119.00, 429.00
TI Travelmate 2000	1Meg	2568034-0001	79.00
TI Travelmate 3000	2Meg	2566996-1	84.00
TI 4000	4Meg, 16Meg		199.00, 1549.00
Twinhead, Altima, Compudyne Tandy 4860, 486SX, DX	4Meg/16Meg		199.00/859.00
Zeos 386SX Notebook	2Meg		99.00
Zenith Master Sport 386SX	2Meg	ZA-300-1	114.00
Zenith Master Sport SL, SLE	2Meg	ZA-4-4	119.00
Zenith Super Sport 286, 286E	1Meg	ZA-180-66	99.00
286E, SX	2Meg	ZA-180-64	179.00
SX Alpha	2Meg	ZA-180-86	179.00
SX Beta	2Meg	ZA-180-87	179.00
Zenith Z-Note 325L, LC	2Meg/8Meg	ZA3250-4/5	129.00/419.00
Zenith Z-Note 425LN, LNC, LNP	4/8/16Meg		269/519/839

LASER PRINTER MEMORY UPGRADES

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Compaq Pagemarq	–	–	–	99	–	–	195	–	–	389	–	–
Epson 6000, Action Laser	–	–	–	125	–	–	209	–	–	–	–	–
Epson Action Laser II	–	–	89	–	Call	–	–	Call	–	–	–	–
Epson 8000	–	–	89	–	Call	–	–	Call	–	–	–	–
Epson 1000, 1500	–	–	–	Call	–	–	Call	–	Call	–	–	–
HP 2, 2D–	–	–	–	119	–	–	199	–	–	–	–	
HP 3, 3D, 3P, 2P 2P+	–	–	–	109	–	–	189	–	–	–	–	–
HP 4, 4M, 4SI, 4SIMX	–	–	–	89	–	–	195	–	–	399	–	–
HP 4L	–	–	59	–	–	–	–	–	–	–	–	–
HP 3SI	–	–	69	–	–	–	189	–	–	379	–	–
HP 4SI	–	–	–	69	–	–	189	–	–	379	–	–
HP Design Jet 600	–	–	–	–	–	–	189	–	–	379	–	–
HP Deskjet 500, 500C, 550	–	59	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	89	–	–	189	–	–	379	–	–
HP Paintjet XL300	109	–	–	–	–	–	304	–	–	499	907	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029	–	–	–	–	–	–	189	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	189	–	–	389	–	–
NEC 90, 290	–	–	–	139	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	99	–	–	–	–	–	–	–	–
Oki 400	–	–	–	89	–	–	–	–	–	–	–	–
Oki 400 E	–	–	135	189	–	–	–	–	–	–	–	–
Oki 830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	124	–	–	209	–	–	–	–	–
Panasonic 4420/4450I	–	–	–	129	–	–	209	–	–	–	–	–
Panasonic 4410/4430	–	–	–	126	–	–	195	–	–	–	–	–
Panasonic 4450	–	–	99	–	–	–	–	–	–	–	–	–
TI XL/PS17/PS35	–	–	55	–	–	–	–	–	–	–	–	–

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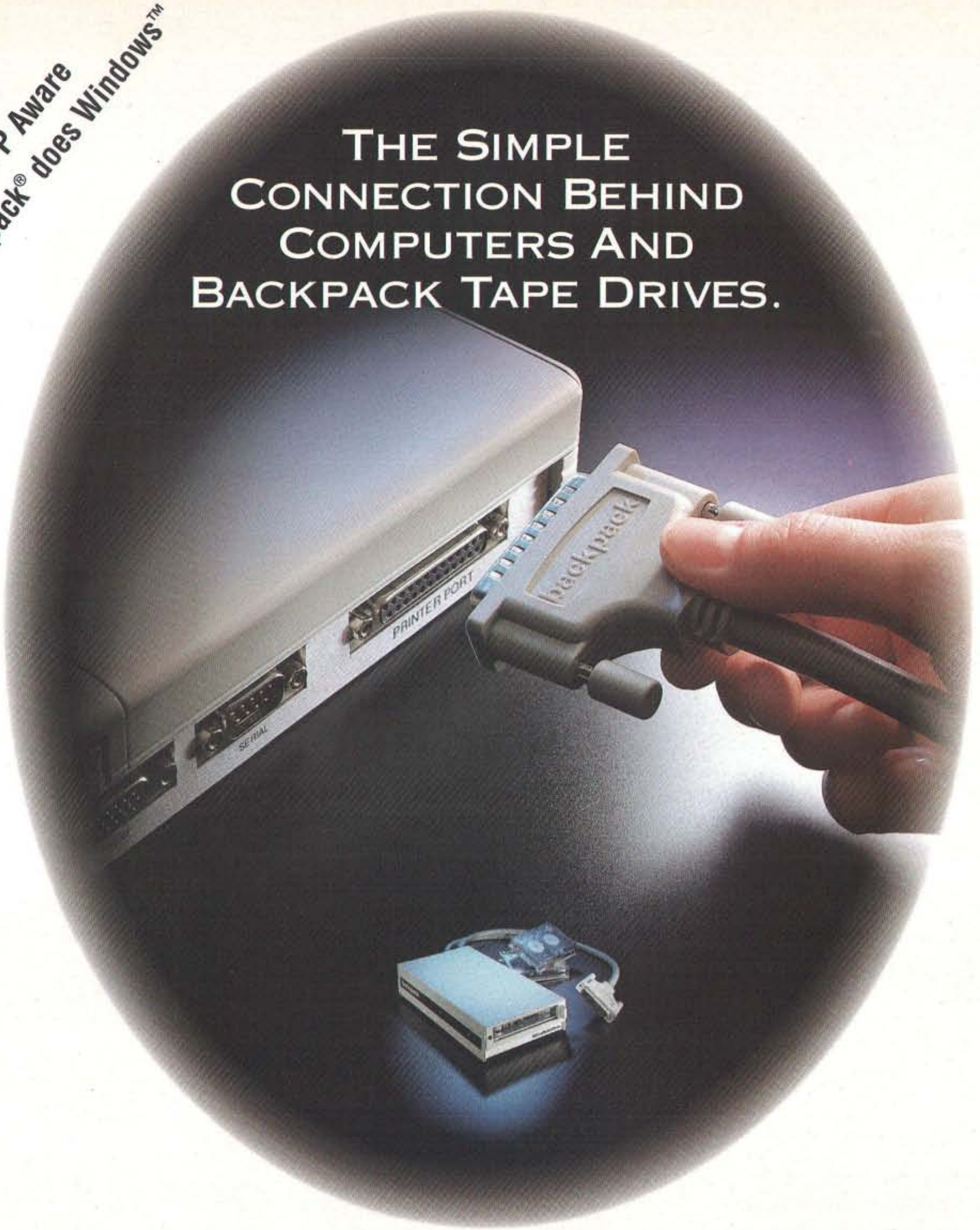

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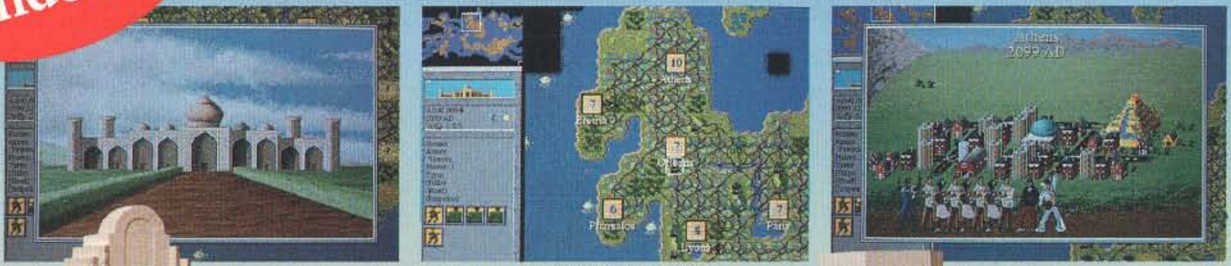

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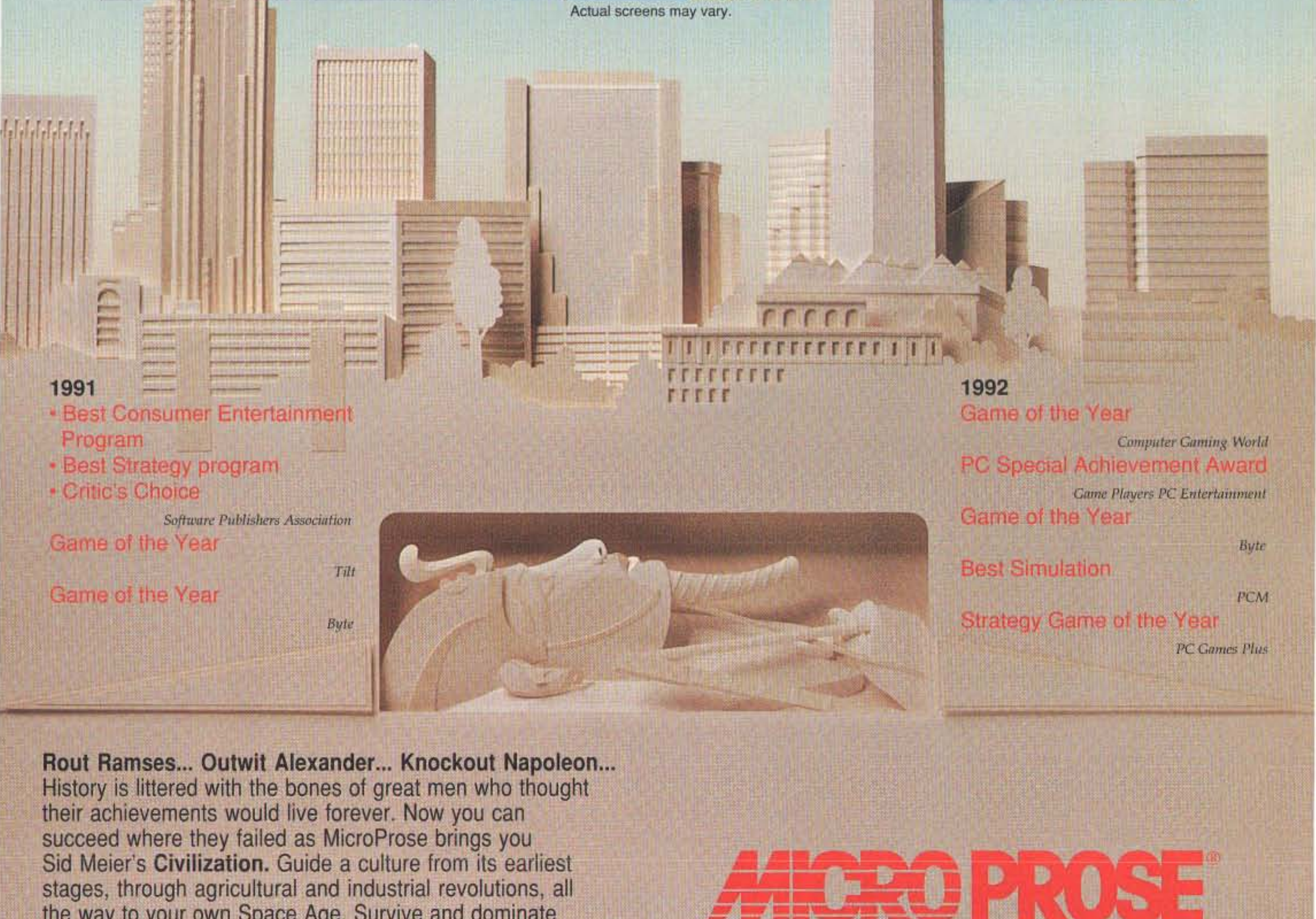

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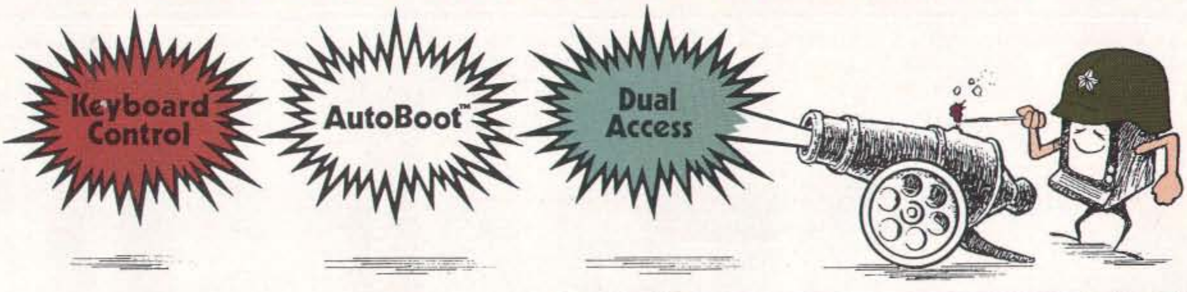

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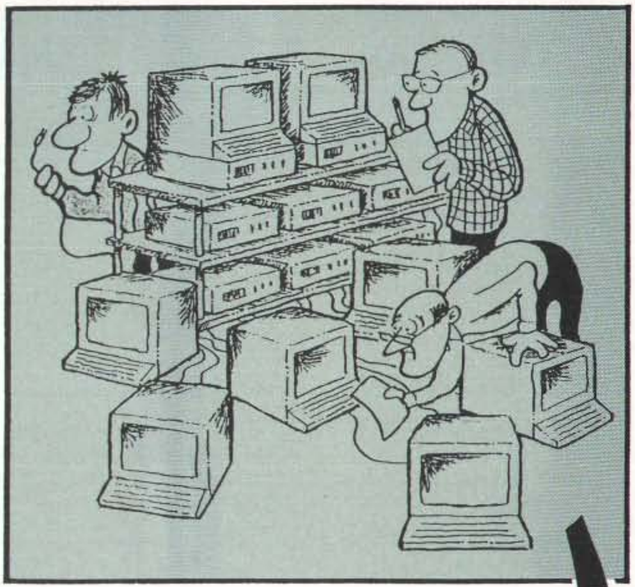

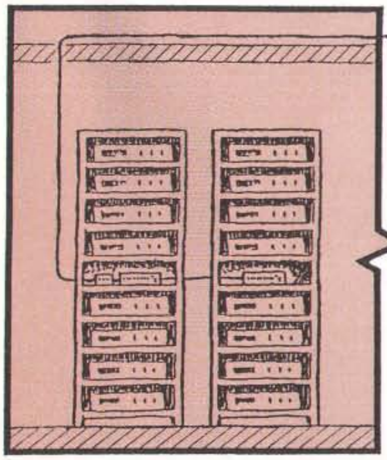

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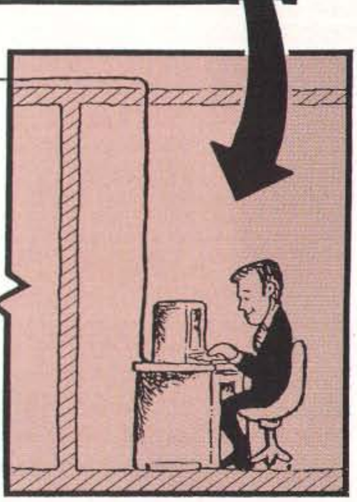

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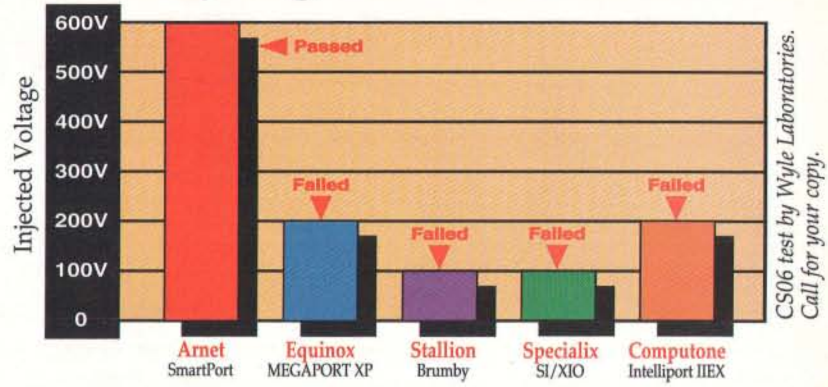

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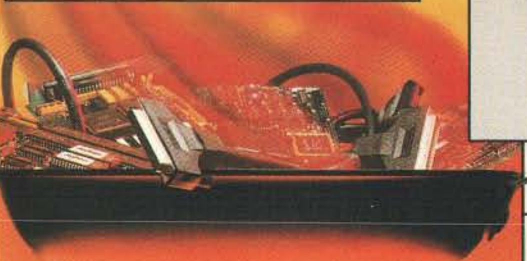

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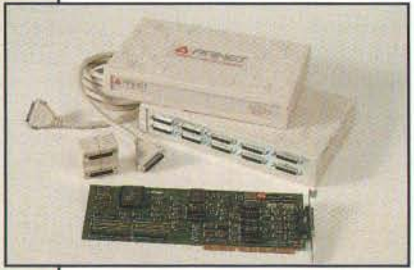

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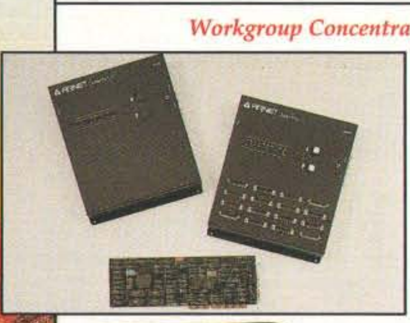

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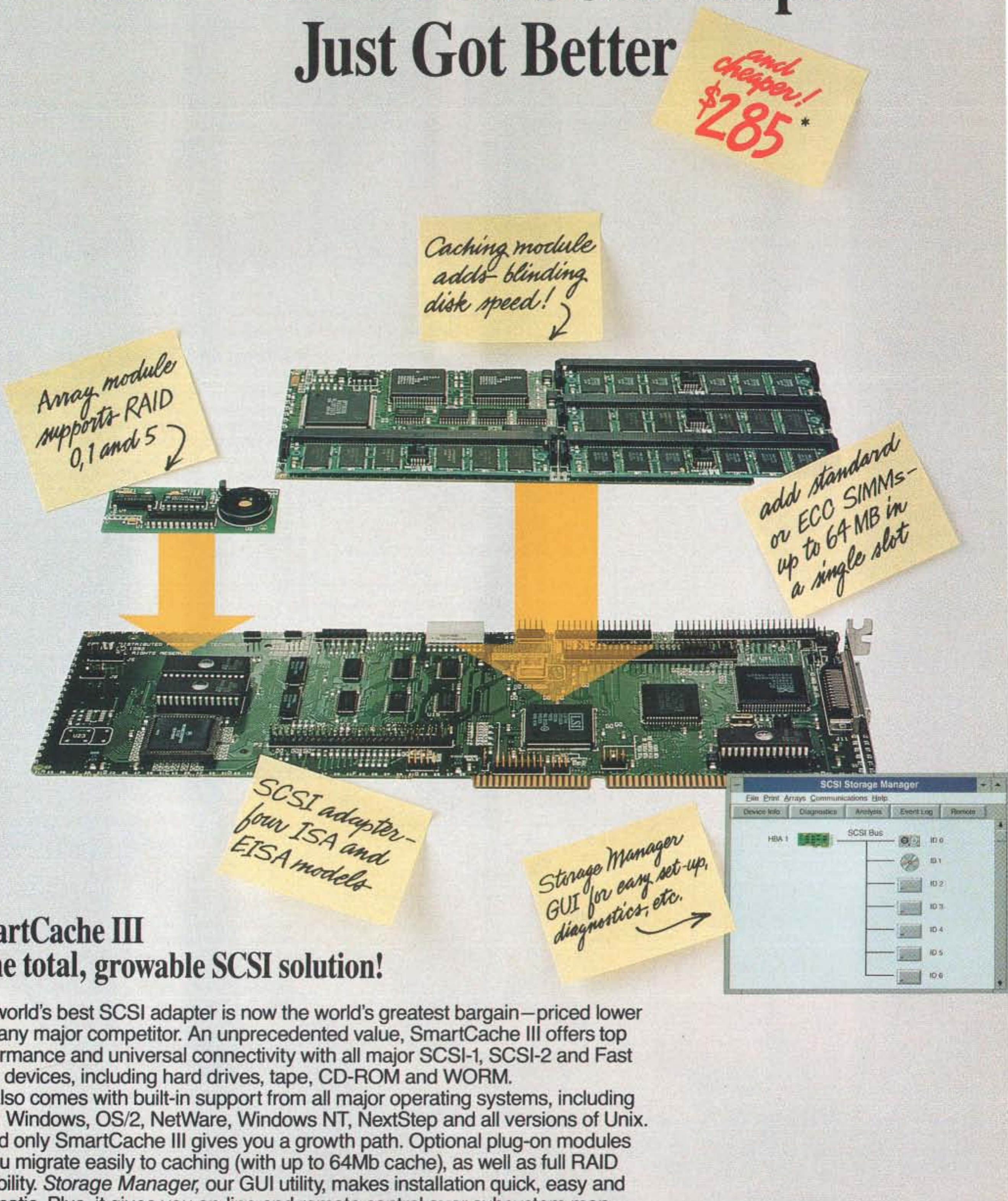
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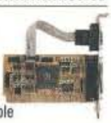

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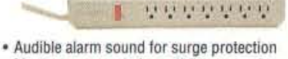

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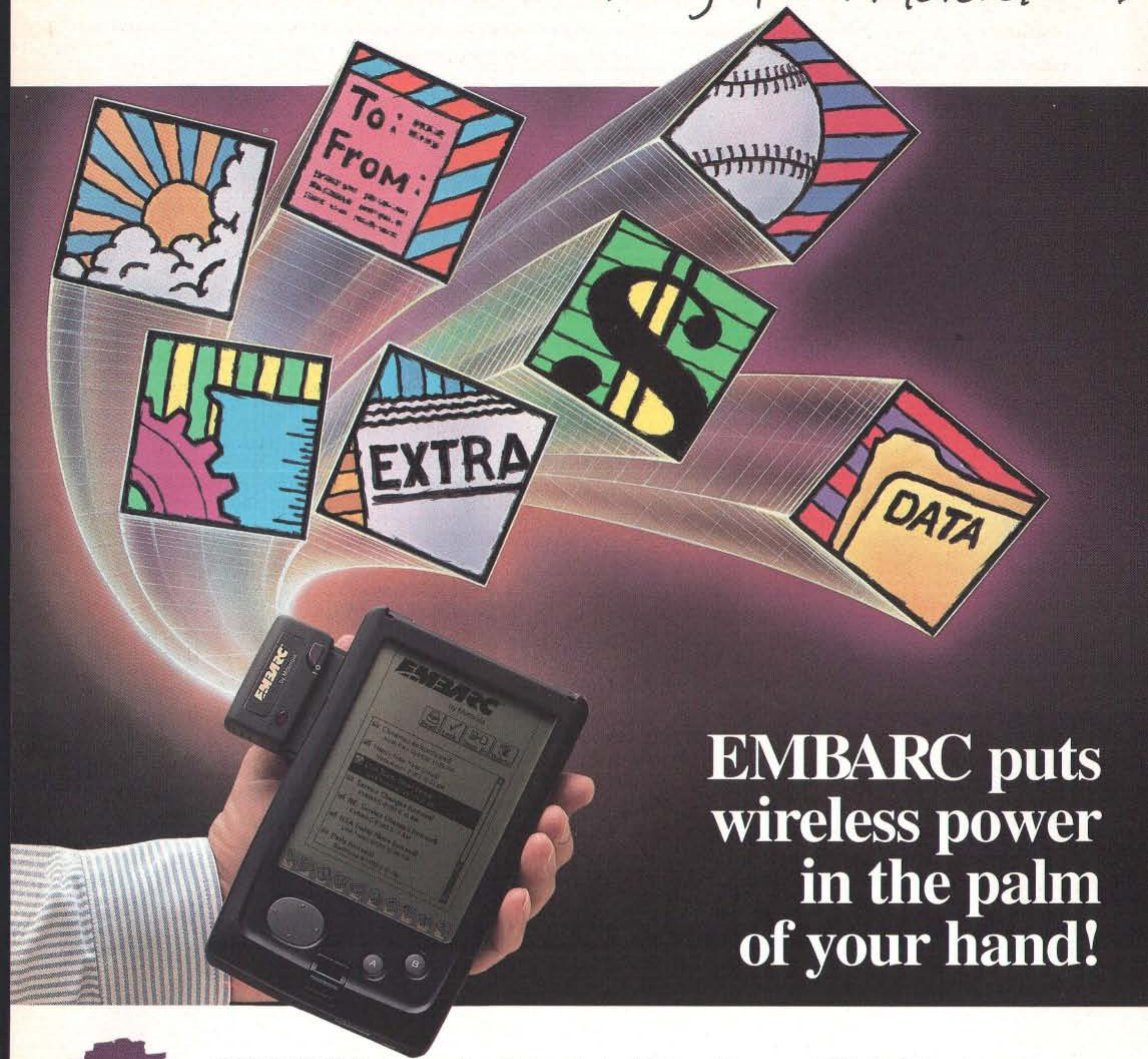

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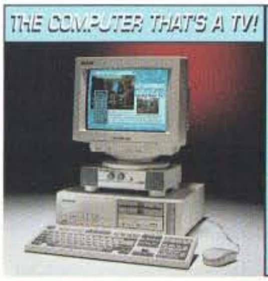

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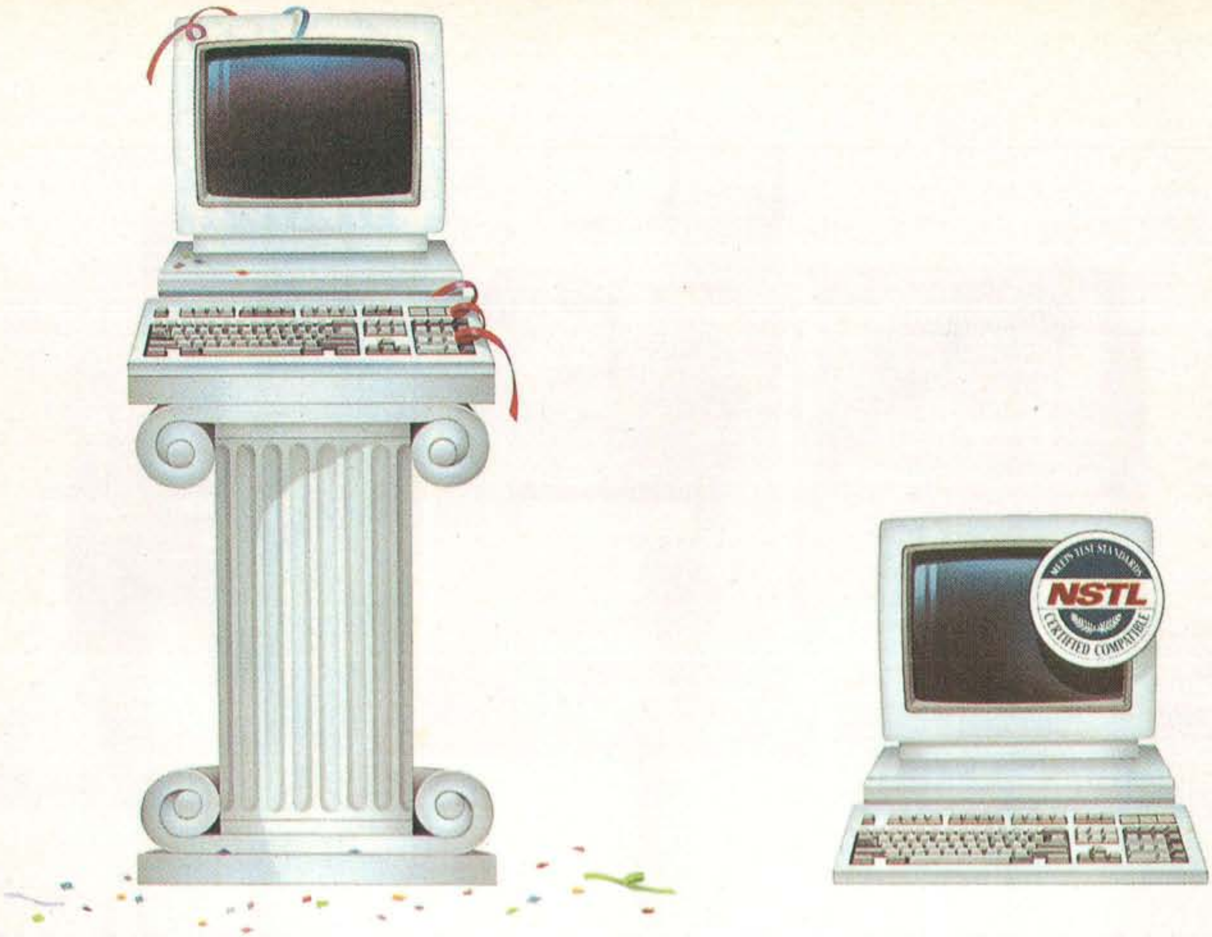

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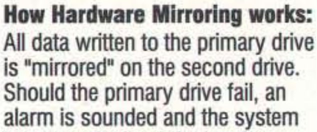
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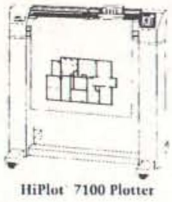

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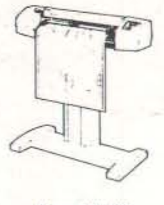

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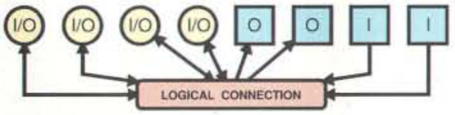

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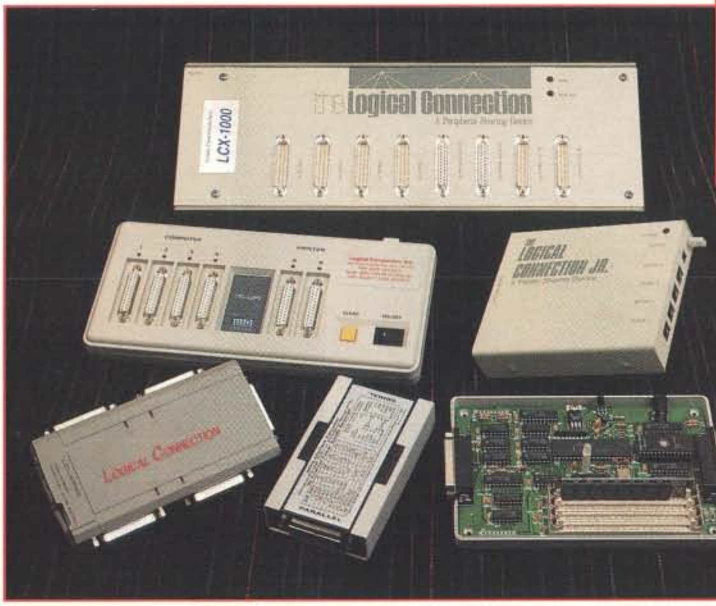

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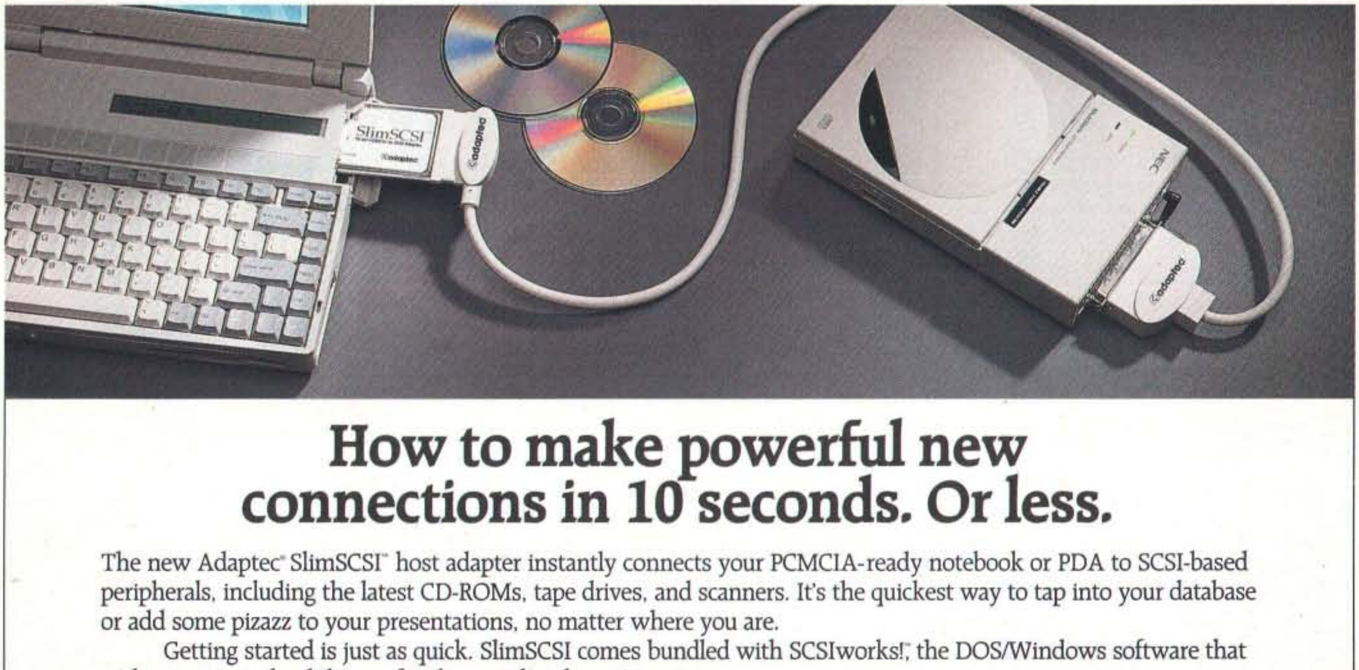

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ST3144A	130MB	16MS	IDE 3.5"	$168
ST3243A	213MB	15MS	IDE 3.5"	$208
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ST3290A	**260MB**	**15MS**	**IDE 3.5"**	**$228**
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ST3390A	360MB	12MS	IDE 3.5"	$310
ST3550A	452MB	12MS	IDE 3.5"	$418
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CP30104	120MB	19MS	IDE	$199
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CP30540	540MB	10MS	SCSI	$620
CP30544A	540MB	10MS	IDE	$630

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7213S	213MB	15MS	SCSI	$240
7245A	245MB	15MS	IDE	$218
7345A	345MB	15MS	IDE	$284
MXT540SL	540MB	8MS	SCSI/IDE	$698
PANTHER (FH) P012S	1000MB	13MS	SCSI	$998
PANTHER (FH) P117	**1500MB**	**13MS**	**SCSI**	**$1358**

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2217	1740MB	10MS	SCSI	$1348
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PS/1 and 386/SX (2121)	2MB	92F9935	$108
	4MB	92F9694	$208
PS/2 30/286;25/286; Adpt Brd 1497259	512K	30F5348	$35
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PS/2 35SX, LS, 40SX,70-E61; 061; 121, Adpt Brd 6450609; 34F3011; 34F3077, 502, 55SX, 655SX, P70, 55LS, 65LS XStation 120 & 130	1MB	6450603	$49
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PS/2 70-A21; A61; B21; B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450603	$49
	2MB	6450608	$90
PS/2 35SX; LS, 40SX, 55SX; LS, 65SX;	4MB	34F2933	$188
PS/2 90 XP, 95 XP, P75 (Pairs), 56 57 (all) 76, 77, PS/1 Pro 2123	2MB	6450902	$94
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PS2/2 35SX; LS; 40SX	8MB	6450129	$428
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	8MB	**07G1421**	**$429**
Thinkpad 710T	4MB	N/A	$228
	8MB	N/A	$448
PS/Note N45	2MB	92F8804	$108
PS/2 Model N51, Notebook SLC, SX	2MB	07G1826	$108
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	8MB	07G1828	$448
Laptop N33SX, L40SX & PSNOTE 182	2MB	79F0999	$108
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L40SX, PSNOTE 182 ONLY	8MB	79F1001	$488

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	8MB	PA8313U	$448

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Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	$59
	4MB	113132-001	$228
Deskpro 386S	4MB Board	113634-001	$299
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Systempro; Deskpro 6 SKT EXP BRD W/2MB		116569-001	$299
Compaq "M"	2-64MB	129160-001	$278
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001, Compaq Pro Signia	1MB	118688-001	$49
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LTE Lite 486/25C	4MB	142337-002	$229
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16MEG X 9 (36 CHIP)			$999			
256X36 1MEG (72 Pin)		$69				
512X36 2MEG (72 Pin)		$98	$108	$128		
1X36 4MEG (72 Pin)		$185	$194	$288		
2X36 8MEG (72 Pin)		$389	$398	$448		
4X36 16MEG (72 Pin)		$698	$738	$848		
8X36 32MEG (72 PIN)			$1795			
16X36 64MEG 72 PIN			$3950			

D-Ram Chips

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64 X 4	$1.95	$2.25	$2.45	$2.95		
256X1 STATIC				$1.95	$2.25	
256 X 1	$1.45	$1.85	$2.40	$3.00	$3.15	$3.20
256 X 4			$6.45	$7.95	$8.45	$8.95
1MEG X 1		$3.95	$4.50	$5.75	$6.45	$6.75
1MEGX1 STATIC				$4.95	$5.25	
1MEGX4				$34.00	$44.00	$49.00

CACHE MEMORY

	15ns	20ns	25ns
8KX8	5.95	5.45	4.95
32X8	8.95	7.75	6.75
64x1	10.95	6.05	5.95
64x4	10.00	8.95	7.95
16x4	6.95	5.45	4.95
128x8		47.00	35.00

PCMCIA 2.0 SRAM MEMORY

AST POWEREXEC, DEC PALMTOP, DELL 320SLi, GRID GRIDPAD, HP 95LX, IBM PC RADIO, MOMENTA PENTOP, NCR 3125 NOTEPAD, POQET, SHARP PC3000/3100, SHARP PC-6700/6741/6781/6785, SHARP PC 6800/6841/6881/6891, ZEOS POCKET PC

512K $98.00 1MB $148.00 2MB $188.00

Laser Printer Memory

MODULE	1MEG	2MEG	3MEG	4MEG	5MEG	8MEG
Apple Laserwriter	CALL					
Brother HL-10V/DV		$165		$264		
Canon LBP4, 4 Lite & 4+	$148	$214				
Compaq Pagemark 15 & 20		$98		$189		$420
Epson Action Laser II, 8000	$195		$263		$329	
Epson + 6000 and many more		$98		$168		
Epson Action Laser 1000 & 1500		$138		$276		$399
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C and 550C		$59 (256K)				
HP2, 2D		$109		$189		
3, 3D, 3P, 2P, 2P+		$123		$189		
HP Laser Jet 4, 111Si, XL300, 1200C				$198		$398
IBM Laser 4019, 4019E (3.5MB)		$139		$168		
IBM Laser 4029 ALL MODELS		$139		$198		
NEC 90, 290		$128				
NEC 95		$108				
OKI 400	$78	$98				
Packard Bell PB9500		$125		$208		
Panasonic 4410/4430		$129		$198		
Panasonic 4420/4450		$128		$198		
Panasonic 4450	$105					
Panasonic 4455		$129				
QMS 410	$119	$159		$249		
Star LS04	$129	$179		$269		
StarScript 4	$128	$178		$258		
Tosiba Page Laser 6		$99		$168		
TI XL/PS17/PS35	$48					

Major Laptop & Notebook Memory

MODEL	MEMORY	PART#	PRICE
AT&T Safari	2MB	37650	$148
	4MB	37651	$298
Bondwell B-310	1MB	23050-09100	$108
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$498
Dell Laptop 212, 320N; 320N+	2MB Mod	310-3204	$129
Dell 325N; NC	2MB Mod	310-3210	$139
Dell NL20 & NL25	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808511	$208
Epson NB-SL/	2MB Mod	A808771	$138
EPSON 25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Carrier	2MB	00263-00	$108
Grid 1500	4MB	52587	$238
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$108
	4MB	N/A	$208
Panasonic CF170/270/370	1MB	CF-BA165	$44
Samsung Notemaster 386S	2MB	SNM002	$195
	4MB	SNM004	$395
Sanyo 17NB; 18NB & ZEOS	2MB	MBC-NBMEM2	$98
Sharp 6220	1MB	CE-621B	$78
Sharp 6640,6781,6681,6785	4MB	N/A	$228
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$108
TI Travelmate 3000SX; WINSX	2MB	2566996-0001	$118
TI Travelmate 4000, WINDX/25 SX/16, SX25, DX2/40	4MB	2581265-001	$298
DX2/50	16MB	**AVAILABLE**	$1995

AST Memory

MODEL#	MEMORY	PART#	PRICE
PREMMIA	4MB	501159-001	$227
	8MB	5L-159-002	$458
MANHATTAN SMP	16MB	501143-001	$898
BRAVO 3/25'S	2MB	500710-004	$128
	8MB	500824-002	$408
ADVANTAGE 386SX/20/25, PRO SX/25 BRAVO 3/33'S	2MB	500962-001	$135
	8MB	500962-002	$434
ADVANTAGE PRO 486DX/33,SX/25, BRAVO LC 4/25S; 33; 33S; 50; 4/66D	2MB	500987-001	$108
	4MB	500987-002	$198
PREMIUM 386/25; 33; 33T II 386SX/16;20;25	1MB	500780-003	$59
	1MB	500780-002	$59
ADVANTAGE 486/25; 33; 33P; SX20, BRAVO 4/33;486/25 PREMIUM 4/25; 33TE, SE 4/33	2MB	500718-004	$119
	2MB	500780-005	$119
ADVANTAGE 486/25;33;33P;SX20,POWER PREMIUM 3/33,4/33;335;50D;66D; PREMIUM 386/33TE;486/25 E 25TE 33 33TE; PREMIUM II 386/25,33,486/33,486SX/20 PREMIUM SERVER SE 4/33	4MB	500780-004	$198
	8MB	500780-001	$398
POWER-EXEC 3/25SL 3/25SL C EL	4MB		$208
	16MB		$878
POWER-EXEC 4/25SL	4MB		$208
	16MB		$878
PREMIUM EXEC 286,386SX/20 25 25C	4MB	500814-003	$208

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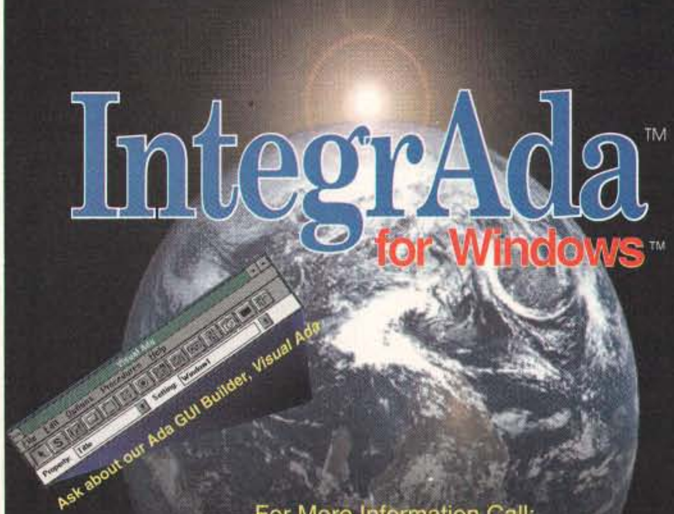
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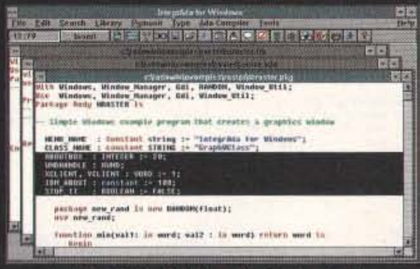
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Insert

```
with Windows, Window_Manager, Gdi, RANDOM, Window_Util;
use  Windows, Window_Manager, Gdi, Window_Util;
package body HRASTER is

-- Simple Windows example program that creates a graphics window

 WIND_NAME  : constant string := "IntegrAda for Windows";
 CLASS_NAME : constant STRING := "GraphAClass";
 ABOUTBOX   : INTEGER := 20;
 WNDHANDLE  : HWND;
 XCLIENT, YCLIENT : WORD := 1;
 IDM_ABOUT  : constant := 100;
 STOP_IT    : BOOLEAN := FALSE;

  package new_rand is new RANDOM(Float);
  use new_rand;

  function min(val1: in word; val2 : in word) return word is
     Begin
```

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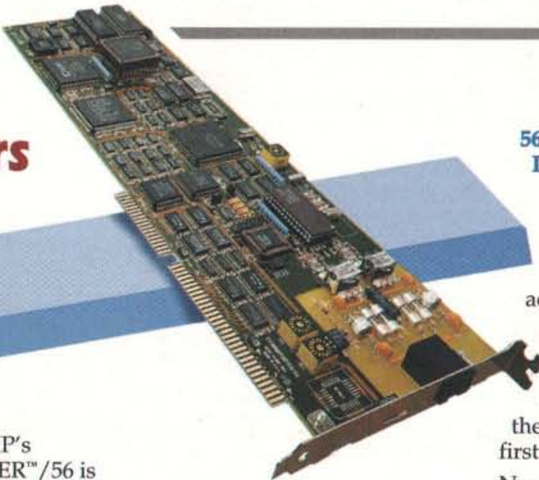

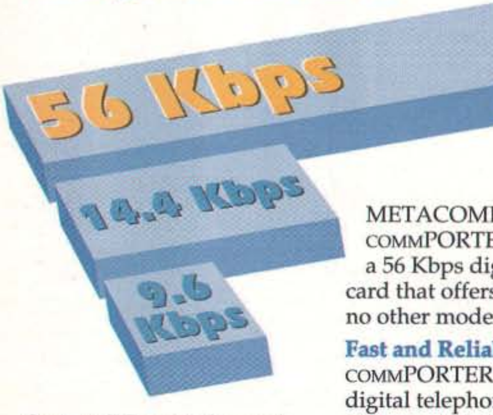

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MCT-VIO	V L Bus IDE and Multi I/O card	$99.95
MCT-IDEFH	16-bit IDE floppy card	$29.95
MCT-VCFH	VESA Local Bus cache IDE controller	$229.95
MCT-VSCSI	VESA Local Bus SCSI-2 controller	$299.95

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VGA Package with Accelerator Card

- 1024 x 768 in 16/256 colors, 800 x 600 in 16/256/64K colors, 640 x 480 in 16/256/64K/16M colors
- 14" diagonal screen; 0.28mm
- 16-bit 286/386/486 PC compatible Windows accelerator card, interlaced and non-interlaced modes

VGA-PKG-1024N		$459.95
VGA-PKG-1024	0.39mm, 1024 x 768 VGA package	$349.95
VGA-MONITOR	0.39mm, 1024 x 768 int. monitor	$269.95
VGA-MON-1024N	0.28mm, 1024 x 768 non-int. mon.	$379.95
VGA-MON-17N	17", 0.26mm 1280 x 1024 non-int. mon.	$799.00

Low Cost Windows Accelerator

- 16-bit 286/386/486 PC compatible; supports interlaced and non-interlaced, analog or multisynch monitors; VESA software compatible
- Up to 1280 x 1024 resolution in 16 colors

MCT-VGA-5000		$99.95
SPEEDSTAR-PRO	16-bit Windows accelerator	$129.95
MCT-VGA-4000	16-bit 1024 x 768/256 color card	$129.95
MCT-VGA-1000	16-bit 640 x 480 VGA card	$49.95

DEVELOPERS TOOLS

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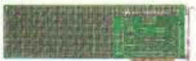
- 286/386/486 compatible
- Displays Power On Self-Test codes
- Works when software won't boot computer
- Includes AMI Diagnostics software

PCODE+		$79.95
PCODE	Above without AMI Diagnostics	$49.95

Wire-Wrap Prototype Cards



JDR-PR2	8-bit with I/O decode layout	$29.95
JDR-PR2-PK	Parts kit for JDR-PR2 decode	$8.95
JDR-PR10	16-bit with I/O decode layout	$34.95
JDR-PR10-PK	Parts kit for JDR-PR10 decode	$12.95
PDS-601	8-bit breadboard with decode	$79.95
PDS-611	16-bit breadboard with decode	$89.95

EPROM Eraser $39.95

- Quickly and simultaneously erase up to 4 standard EPROMs
- Includes wall plug power supply

DATARASE II		$39.95

EPROM Programmer

- Programs devices up to 512K bits, plus 27C100, 27C101, 27C301, 27C1000, 27C1001, 27C2001, 27C4001 & more
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- ZIF socket accepts 0.6" wide DIP IC's to 32 pins

MOD-MEP-1A		$199.95
MOD-MEP-4A	As above with 4 ZIF sockets	$269.95

SYSTEM BASICS

3-Button Mouse $14.95

- Accuracy 290-1450 DPI
- Opto-mechanical design

JDR-MOUSE-3		$14.95
MOUSE-PAD	Keeps mouse ball free of dirt	$4.95
MCT-GAME	Dual port game card	$29.95
JSTK-300	Joystick	$9.95
JSTK-500	Pilot-style joystick	$19.95

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Low Cost Internal CD-ROM Drive

- 5-1/4" half-height internal drive with 1/2 length interface card
- 150Kb-175Kb per second, 350ms average access time
- Includes drive, interface card, cables and manual

CDROM-I		$199.95
CDR-84	NEC internal dual speed CD-ROM drive	$499.95
MCT-SOUND	8-bit sound card	$49.95
SB-DLX	SoundBlaster 8-bit sound card	$89.95
VIDEOBLASTER	16-bit video card with software	$329.95

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TEAC

- 5-1/4" half-height beige drive
- Supports 1.44Mb, 1.2Mb, 720Kb & 360Kb diskettes

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FDD-2.88A	2.88Mb 3-1/2", Beige	$99.95
FDD-1.44A	1.44Mb, 3-1/2", Beige	$59.95
FDD-1.44X	1.44Mb, 3-1/2", Black	$59.95
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3.5HD-BULK	3-1/2" 1.44Mb DS/HD disks w/labels & tabs	$.59 ea

250Mb Tape Drive $169.95

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- QIC-40 read and QIC-80 read/write compatible
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- Includes DOS backup software and manual

9250I		$169.95

IDE Hard Drives

PART #	BRAND	CAP.	SPEED	TYPE	PRICE
CP-30084	Conner	84Mb	19ms	3-1/2" IDE	$189.95
ST-3096A	Seagate	89Mb	16ms	3-1/2" IDE	$189.95
ST-3144A	Seagate	131Mb	16ms	3-1/2" IDE	$209.95
CP-30174	Conner	170Mb	17ms	3-1/2" IDE	$229.95
CP-30254	Conner	250Mb	14ms	3-1/2" IDE	$269.95

Seagate IDE Drive Kits

- 16-bit 286/386/486 PC compatible card
- Includes hard drive
- 16-bit controller interfaces two hard and two floppy drives

HDKIT-80	Kit with 89Mb ST-3096A drive	$209.95
HDKIT-130	Kit with 131Mb ST-3144A drive	$229.95
HDKIT-210	Kit with 214Mb ST-3243A drive	$269.95

UPGRADE COMPONENTS

Dynamic RAM

PART #	SIZE	SPEED	TYPE	PRICE
41256-80	256K x 1	80ns	DIP	$2.39
1MB-80	1M x 1	80ns	DIP	$4.99
41256A9B-80	256K x 9	80ns	SIMM	$14.95
41256A9B-60	256K x 9	60ns	SIMM	$16.95
421000A9B-80	1M x 9	80ns	SIMM	$49.95
421000A9B-60	1M x 9	60ns	SIMM	$59.95
424000A9B-80	4M x 9	80ns	SIMM	$159.95
424000A9B-60	4M x 9	60ns	SIMM	$179.95

DUE TO CURRENT MARKET CONDITIONS, CALL FOR CURRENT DRAM PRICES

Math Co-Processors

intel.

PART #	SPEED	PRICE	PART #	SPEED	PRICE
8087-2	8MHz	129.95	80387-SXP	≤25MHz	74.95
8087	5MHz	89.95	80387-DXP	≤33MHz	79.95
80287-XL	12MHz	74.95	80487-SX	≤25MHz	369.95

OverDrive Processors

ODP486-SX20	For 20MHz 486SX OverDrive socket	$299.95
ODP486-SX25	For 25MHz 486SX OverDrive socket	$359.95
ODP486R-DX25	Replace 25MHz 486DX w/50MHz DX2	$359.95
ODP486R-DX33	Replace 33MHz 486DX w/66MHz DX2	$529.00
ODP486-DX33	66MHz 486DX2 for OverDrive socket	$529.00

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- Full Hayes command set compatibility
- QuickLink II communications software

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MCT-24I	2400 baud internal modem with s/w	$49.95
FAXM-SWITCH	Connect fax/modem/phone on 1 line	$89.95
FAX-SWITCH	Above without modem connection	$59.95

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- Uses 256K x 9, 1M & 4M x 9 60ns SIMMs (0K installed)
- ZIF CPU socket for upgrades
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MCT-M486VL-33	33MHz 486DX VESA local bus	$599.00
MCT-M486VL-66	66MHz 486DX VESA local bus	$899.00
MCT-M486EV-66	66MHz DX2 w/VESA & EISA bus	$999.00
MCT-M386SX-33	33MHz 386SX	$129.95
MCT-C386-33	33MHz cache 386	$249.95
MCT-C386-40	40MHz cache 386	$299.95
MCT-M486SX-33	33MHz cache 486SX	$449.95
MCT-M486-33	33MHz cache 486DX	$549.00
MCT-M486-50	50MHz cache 486DX	$799.00
MCT-M486-66	66MHz cache 486DX2	$849.00
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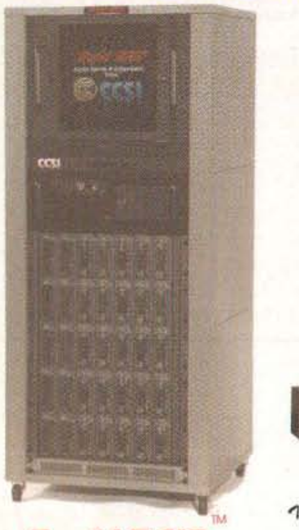

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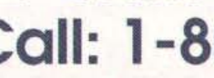

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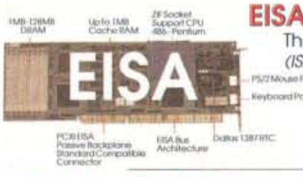

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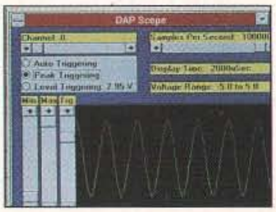

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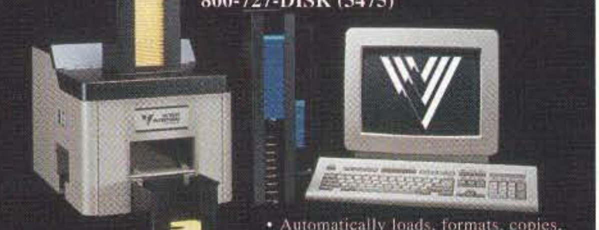

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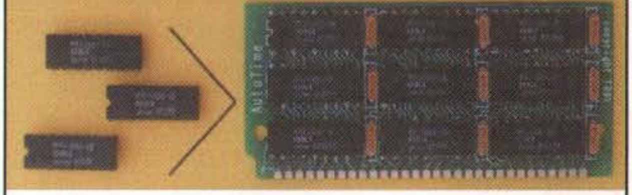

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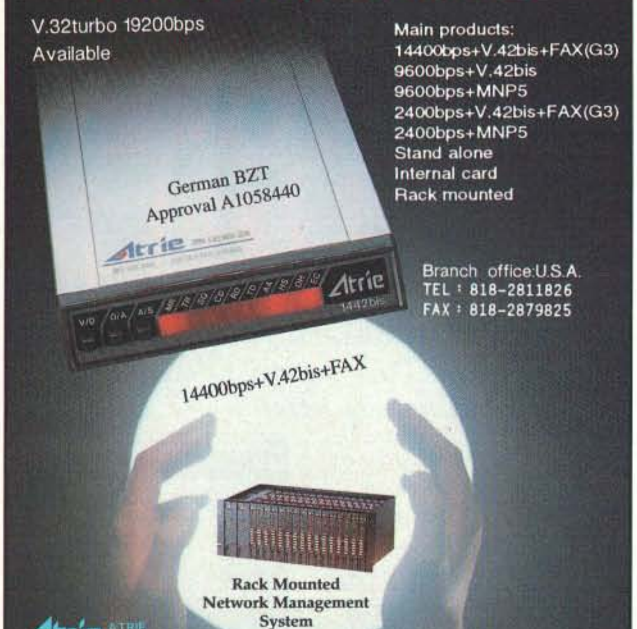

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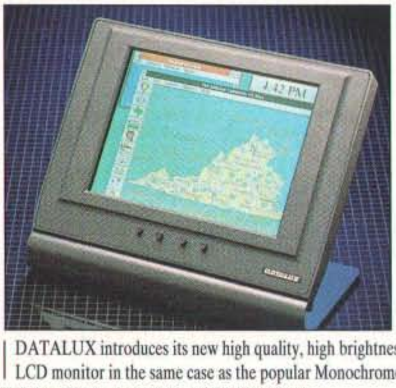

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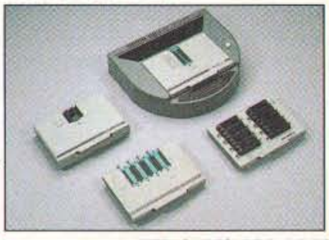

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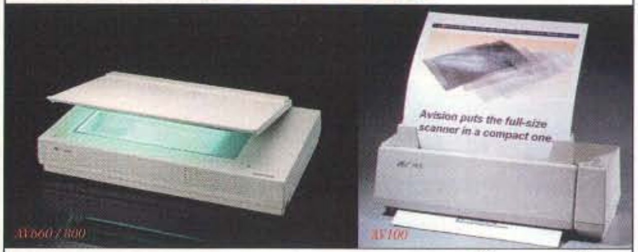

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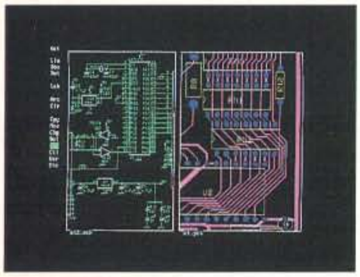

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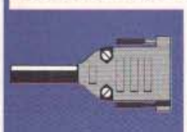

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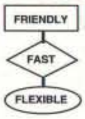

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596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

YOUR DIRECT LINK CARD

For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343

BYTE
TNT MAILFAST
FRG/BOS/700252/MO1
P.O. Box 66
Hounslow
TW5 9RT
England

PLACE
POSTAGE
HERE

See reverse side for card.

1. Circle the Numbers on Your Direct Link Card

Circle the numbers which are found on ads and articles in this issue or circle the product category number and receive information on all advertisers listed in that category.

2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!

BYTE

YOUR DIRECT LINK CARD

For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343!

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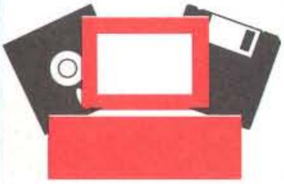
Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!



BYTE

Yes, I want FREE information on the following products!

Fill out this coupon carefully. ***Please Print.***

Name

Title

Company

Address

City Country Code

Bus. Phone Fax

A. What is your primary job function/principal area of responsibility? (Check one)

1 ☐ MIS/DIP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level 9 ☐ Professional
8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply)

12 ☐ PC/MS-DOS 15 ☐ Unix
13 ☐ DOS + Windows 16 ☐ MacOS
14 ☐ OS/2 17 ☐ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

18 ☐ 1-25 20 ☐ 51-99
19 ☐ 26-50 21 ☐ 100 or more

February 1994 *90 97 99*

Valid until April 30, 1994

Product Category Information

Circle the numbers below for information on the entire category of products you're interested in.

Hardware

Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
Programming Languages/ Tools	40
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing	48

General

Books/Publications	49
Recruitment	50
Miscellaneous	51

Inquiry Numbers 52-233

52	78	104	130	156	182	208
53	79	105	131	157	183	209
54	80	106	132	158	184	210
55	81	107	133	159	185	211
56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

Inquiry Numbers 234-408

234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407
258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 591-765

591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

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2. Print Your Name and Address

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3. Product information will be rushed to you from the selected companies!

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YOUR DIRECT LINK

ADVERTISER CONTACT INFORMATION

Inquiry No.		Page No.	Phone No.
127	PERSOFT INC	193	800-368-5283
525	PHAR LAP SOFTWARE INC	48IS 13	617-661-1510
526	PHILIPS MONITORS	8-9	+31-40-73-39-83**
*	PINNACLE MICRO	72A-B	714-727-3300
128-129	PINNACLE MICRO	73	714-727-3300
130	PKWARE INC	128	414-354-8699
131	POPKIN S/W & SYSTEMS INC	43	212-571-3434
532	PORA CORP (INT'L)	60	+886-2-8835582**
*	PRODEA SOFTWARE CORP	211	800-PRODEA 1
115	PROGRAMMER'S PARADISE	36-37	800-445-7899
160-161	PROXIMA CORP	159	619-457-5500
	Q		
220	QUADRA INTERACTIVE	218	619-431-9530
235	QUALSTAR CORP	248	818-882-5822
132	QUARTERDECK OFFICE SYSTEMS	53	310-392-9851
133	QUATECH INC	214	800-553-1170
	R		
134-135	RAINBOW TECHNOLOGIES	65	800-852-8569
265-266	RCI	243	908-874-4072 ext. 71
527	RECOGNITA (INT'L)	CIII	+36-1-2018925
201	RECORTEC INC	231	800-729-7654
136-137	RGB COMPUTER & VIDEO INC	110	800-535-7876
138	ROSE ELECTRONICS	198	800-333-9343
	S		
139	SEQUITER SOFTWARE INC	170	403-437-2410
256-257	SHAFFSTALL CORP	249	800-248-3475
250-251	SIGMA TECH SOFTWARE	243	818-368-6132
*	SILICON GRAPHICS (INT'L)	136	415-940-4343** ext. B23
*	SILICON GRAPHICS (N.A.)	136	800-431-4331 ext. B23
274	SILICON VALLEY COMPUTER	233	415-967-1100
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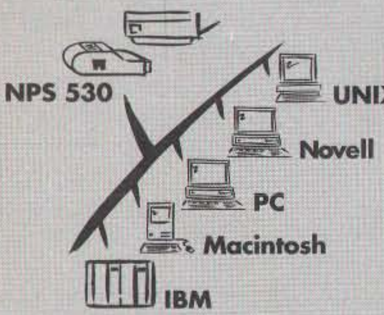
AXIS, founded in Sweden 1984, has an international network of distributors.
AXIS offers a range of print servers for connecting printers to networks.
AXIS develops all products in-house and makes use of the latest RISC technology.

PLUG AND PRINT

IN THE SIXTIES THE WORLD KNEW NOTHING ABOUT NETWORK PRINTING!

NPS 530 for Ethernet

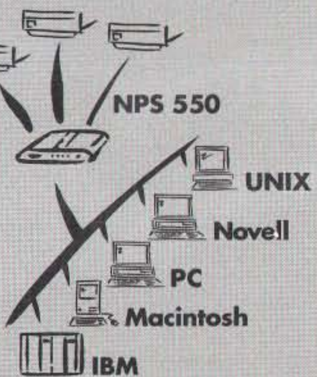
Axis NPS 530 is a pocket-sized print server for Ethernet networks. It plugs directly into the printer's parallel port and allows you to print at full speed.



NPS 550 for Ethernet

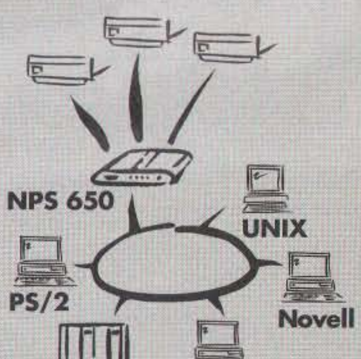
Axis NPS 550 is a print server that can connect two parallel printers and one serial printer anywhere in an Ethernet network.

PC MAGAZINE EDITORS' CHOICE
December 7 1993
Axis NPS 550
Multiprotocol Print Server



NPS 650 for Token Ring

Axis NPS 650 print server can connect two parallel printers and one serial printer anywhere in a Token Ring network.



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Commentary Steve Evangelou

Layoff Software

A program concept whose time has unfortunately come

For the computer industry, the *l*-word (*layoff*) is the crazy aunt down in the basement—there's no way to get rid of her, and you know she's going to pop her head up sooner or later. Sure, a company can scare off some people by freezing salaries and canceling the Friday beer bust. Or they can try early-retirement incentives, and risk losing their best employees. But sooner or later, it always seems to get back to the *l*-word.

In an industry that offers 17 different desktop organizers, you'd expect someone to be working on new approaches to this problem, and you'd be right. One software company has instituted an Employee Departure Bonus Program. Instead of paying a bonus for getting a friend to join the firm, the EDBP offers a sliding scale of payments for each employee hounded into leaving the company. Demoralizing a vice president of marketing into jumping ship earns a $1000 reward, which is a lot cheaper than a golden parachute. In fact, the EDBP has been so successful there is hardly anyone left to depart.

Even more promising are a bunch of new layoff programs that are filling an ever-expanding market niche. Layoff software is any program used to minimize personnel costs or otherwise smooth the process of laying off employees. These programs won't make layoffs go away, but they can make them a lot easier to deal with. Consider the following marketing literature for Layoff Pro, coming soon from Belly Up Software of Novato, California.

Customer Profile: Layoff Pro is aimed at the following group: employees.

Multiple résumé formats: Layoff Pro has more than 20 editable résumé formats, each designed to be both eye-catching and impressive, giving new luster to the same old job experience. Popular formats include:

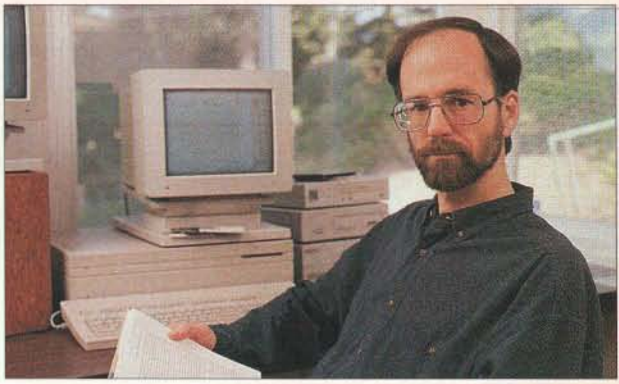
Senior Software Engineer: Regardless of where it is printed, your résumé will look like it came from a dot-matrix printer. It includes Acronimm Generator (AC) and Random Mispeller (RM) (we're using both on this dcoument) for genuine techie feel.

Technical Writer: Your capabilities are explained in words and phrases so simple even a user could understand them. Correct grammar, spelling, and punctuation guaranteed.

Project Manager: Using the special thesaurus with only positive adjectives, you can turn *termination* into *career adjustment opportunity* with the touch of a key! Jargon Expander algorithm makes you sound like an expert without knowing anything.

Job prospect database: Updated quarterly to remove any companies that have had recent layoffs of their own.

Cover-letter generator: Uses our patented auto-brag technology, which enables you to claim sole responsibility for any project you were even remotely involved with.



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Letters of reference: Choose from Bill Gates, John Sculley, Scott McNealy, Hillary Clinton, and other heavyweights. Includes imitation letterhead.

Layoff etiquette: Layoff Pro includes an on-line guide to correct office behavior under the stress of layoffs, either real or impending. Topics include: spotting the next layoff, exit interview do's and don'ts, investment opportunities for severance pay, and inexpensive disguises for the unemployment office.

Quick erase: This feature lets you quickly and permanently erase any embarrassing personal letters or game software from your hard disk or any disk accessible through a network connection. (Not to be used for important company data.)

Belly Up Software plans to release the following related products in the near future:

Layoff Pro II: This release will address additional market segments, including doctors, lawyers, Indian chiefs, rich men, poor men, beggars, and thieves.

Expense Slasher: This utility randomly deletes items from your current home budget; works with most popular spreadsheets and finance programs.

Let's Make a Deal: Set up like the familiar TV game show, this program dispenses helpful negotiating tips for dealing with banks, utility companies, car dealerships, and collection agencies.

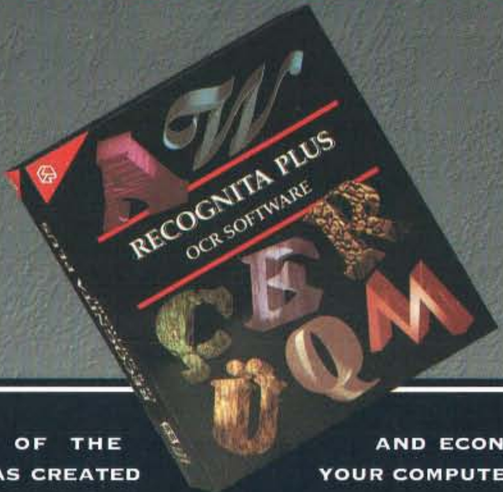
Best Offer: An on-line guide to running a successful garage sale.

Bankruptcy Pro: Everything you need to know about filing for Chapter 11.

Layoff Pro is not vaporware—my boss left a beta copy in my in-box the other day. My only question is, am I supposed to review it, or is this his idea of a subtle hint? Let's see now, how does that spotting-the-next-layoff feature work? ■

Steve Evangelou works for himself as a freelance writer in Oakland, California. You can contact him on BIX c/o "editors."

SHAPING UP
FOR GREATER RECOGNITION



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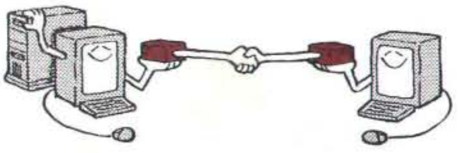

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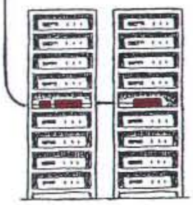

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